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THE AMERICAN SOCIETY OF NATURALISTS
CHANCE OR PURPOSE IN THE ORIGIN AND EVOLUTION OF ADAPTATION[1]

THE naturalist lives surrounded by fellow men, whose ideas concerning the origin of living things are still totally at variance with his own. To them creation is a historical drama, and with the act of creation its *purpose* was fulfilled. The naturalist lives surrounded by fellow animals, that show on the whole no change except the chance fluctuations of the seasons or of the years. They give to ordinary observation every evidence of permanency, but no evidence of evolution, and only the highly specialized student reports at times the appearance of new forms.

It is surprising, with these deadening influences always present, that we should sometimes fail to fully realize that evolution is a process now taking place in the same way that it has taken place in the past; that it is a process that we can study directly; something that possibly we can control and direct, and upon our knowledge of which the destiny of the human race may depend.

Convinced that evolution has taken place, admitting that it is still going on, nevertheless the position of the naturalist in regard to the causes of evolution is far from satisfactory and most unsatisfactory concerning the *origin and evolution of adaptation.*

The evidence that evolution has taken place we owe primarily to the paleontologist, but it is historical evidence, at best,

[1] Presidential address at the dinner of the American Society of Naturalists in Boston, December 29, 1909.

and history, as Voltaire said, is "a permanent pleasantry whose sense escapes us."

It is the sense of the process that escapes us. Comparative anatomy has built up a monument of industry, but the foundations lie in the sand. The *assumption* of the theory of evolution makes intelligible the whole of comparative anatomy as no other theory has ever done, and has led many biologists to conclude that it is, therefore, a correct interpretation. I, for one, do not doubt this, but comparative anatomy has nothing serious to say concerning the factors of evolution.

And if we turn to my favorite field of embryology, what is the answer? Von Baer, who enunciated one of the fundamental generalizations of embryology, did not accept the theory of evolution. The recapitulation theory, the most widely accepted statement in regard to the historical side of embryology, has been exaggerated, overdone, and in some quarters thrown into the waste heap of premature speculation. I do not doubt that it aroused a young generation to great enthusiasm for investigation, nor do I doubt that the study of embryology furnishes many clues to the relationships of animals; but I venture to affirm that it has done nothing to advance our knowledge of the *causes* of evolution.

Are we not in rather a hazardous position concerning our belief in the evolution of adaptation? It may be a belief more in accordance with known facts than its great rival, the theory of special creation, but however convinced of its truth, we remain unsatisfied until we can tell how evolution and adaptation have taken place, how they are going on at the present time, and what the future has in store for us.

I hear some one say, "But we know how evolution has taken place; by natural selection." "Perhaps," says his neighbor, "but the Lamarckian principle is the chief agent of adaptation." "Maybe," says a third, "but the environment has had more to do with the origin of species than any other factor, and 'we can prove it.'" "No," says the psychologist, "it is the will to live that brings about evolution, for it is the creative principle of evolution—l'élan de la vie." And the pragmatic philosopher, at the head of the table, adds, "You are all right, my children, evolution has taken place in whatever way you find it advantageous to think of the process."

Comment seems superfluous, but in the flux of opinion concerning the process of evolution there are two general points of view of fundamental moment for every thinking man.

To the majority of evolutionists accepting the theory of natural selection, evolution is the result of accidental variation; it is haphazard or due to chance. By taking this ground the selectionist feels that he stands on the evidence of facts, for "chance" variations he holds can be demonstrated to occur, and secondly that he escapes the onus of explaining how the adaptive variations arise, for he believes that there is no relation between the creation of something new and the part it subsequently plays in the welfare of the species.

But to other minds, or temperaments, such a conception of the origin of the living world seems inconceivably crude. To them it seems beyond comprehension that the evolution of a man, for instance, from an amœba, for example, has been due only to accidental or chance happenings. They *feel* that some more direct and intimate relation must exist between the origin of a new part and the use it comes to subserve.

Grant that many false steps have been made, admit that countless individuals

have been born to perish, what has given us the *progressive* chains of beings? Chance, says one extreme view; purposeful response, says the other.

I need not repeat before this body of naturalists that to-day we have dropped entirely the antiquated use of the word chance as something not subject to the laws of mechanics. That conception of chance arose, no doubt, because chance events are those that can not be predicted individually and what he can not predict seems to the confused thinker to disobey the causal law. Out of his ignorance he imagines blind happenings.

We mean by chance, in ordinary speech, two main things. "I chanced to be there," we say, meaning that our being there was not connected with what occurred, not that mysterious forces, instead of two legs, carried us there. The other meaning is that of a large number of possible combinations a particular one happened.

Darwin used chance *variations* as synonymous with fluctuating variations. He clearly understood that a chance variation is one due to some unknown cause or combination of causes.

But it is the other sense of the word chance that is of capital import for the matter we have in hand. In this sense chance means that a variation having appeared, *chanced* to find a suitable environment. In this latter sense only is it desirable to use the word chance in connection with organic evolution. The confusion of this meaning with the other one which applies to the *origin* of a variation has led to a regrettable obscurity in the minds of some evolutionists.

Darwin's famous book is entitled "The Origin of *Species*" but his theory of natural selection explains the *adaptations* of living things. Darwin was in a large measure concerned with demonstrating that species, in the Linnæan sense of species, arose by evolution, not by special creation. He has himself said:

> Hence if I have erred in giving to natural selection great power, which I am very far from admitting or in having exaggerated its power, which is in itself probable, I have at least, as I hope, done good service in aiding to overthrow the dogma of separate creations.

But to-day, accepting evolution, we are concerned as to whether the theory of natural selection explains the *origin of species,* or whether it explains the *adaptations* of animals and plants. These two questions have often been merged into one, yet it is notorious that, by systematists, specific distinctions rest in many cases on differences that have no adaptive significance whatever.

If, then, the systematist's definition of species is what we mean when we speak of species, and this definition does not concern adaptive characters (or only incidentally) clearly it is futile to attempt to explain the *origin of species* by the theory of natural selection.

Curiously enough, we do, I think, when speaking of *adaptation,* attach one meaning to the word species and another meaning when speaking of *evolution.* In the latter case we often fall back upon the definitions of the systematist. When we speak of the evolution of adaptations, through natural selection, however, we are thinking of organisms as groups that are structurally and functionally adapted in different ways to the environment in which they live, and differ from all other groups in these relations to the environment. These adaptive characters do not, however, in most cases lend themselves to sharp definition for purposes of identification and are shunned, therefore, by the systematist. If I am right on this point, the characters of systematic zoology are, at most, only parts of adaptive structures

and are generally only by-products of the process of evolution—characters that belong for the most part to the dump-heap of evolutionary advance; and whilst they, like all characters, call for explanation, the student of adaptation of the living world (regarding adaptation as the fundamental problem of evolution) will pass them over as of trivial importance for his ends.[2]

Our problem, then, concerns the adaptations of species, and from this time forward when I speak of the origin of species I mean the origin of the adaptive characters of species.

Modern thought has rejected the theological view of the miraculous origin of animals and plants, but philosophy still discusses the question whether there is something purposeful residing in matter or controlling matter that has brought about the adjustments between the animal and its environment, while science turns rather to the question whether adaptation is not the result of a reaction between the organism and the outer world; and if so, in what sense we are justified in applying chance to such a process. Let us examine briefly the philosophical and scientific points of view.

We have sufficient evidence to show that animals and plants *sometimes* respond directly in an adaptive way to changes in their environment; to such agents as food, or light, heat and cold, moisture and dryness.

When we recall that since the first beginning of life on the earth, plants and animals have been subjected to these kinds of physical influences, and the forms that have persisted are those that have reacted adaptively, it is not surprising that they should respond at times, if not always, adaptively even under new conditions. The fact that some directly adaptive responses occasionally occur can not, however, be used as an argument that all adaptive responses have so arisen.

The adaptive response to poisons, or to foreign bodies of any kind introduced into the animal, is one of the most remarkable phenomena of adaptation. In the great majority of cases the response is specific for a particular poison, and the poison, such as abrin, may be one with which the animal can have had no previous experience. A leading pathologist has not hesitated to state in this connection:

> If our studies in infection and immunity have any meaning, they teach us, that . . . adaptation is primarily an active process or at least inevitable and in no sense subject to chance. It is not the mere fortuitous, passive modification of living matter in a favorable direction, but a process whereby that living matter is able to a greater or less extent to change and suit itself to its environment.

The adaptive character of these responses loses some of its mystery, although none of its interest, if, as has been suggested, the poison acts by becoming first incorporated in the living tissue and the living tissue in consequence sets free certain products of the reaction or possibly products of its own break-down whose presence in the blood serves to lock up the poisonous substances. It has been suggested that this process is similar in many ways to the process of assimilation of food by the organism. If this point of view recommends itself, it shows how the organism is a machine already prepared to do this sort of work, and the cases that fill us with astonishment may turn out to be but variations of a process essential to all metabolism.

[2] This statement is not, of course, to be understood to underrate the great value of systematic work; I wish only to emphasize that the evolution of adaptive characters, rather than of systematic characters, is the question of absorbing interest to the naturalist.

More familiar is that class of adjustments by means of which, through use of a part, its functional activity becomes more effective; the muscle grows strong, the skin thickens, the iris contracts and even the bones bear witness to stresses and strains. Here also we are beginning to see that these adjustments may be nothing more than extensions of the normal processes of growth—function breeds function, because the very act of functioning is itself a step towards further change in the same direction.

One of the most remarkable adaptations is the development of a whole embryo out of half of an egg. But here, too, we have come to see that the result is not due to any special and sudden development of a new and wonderful power, but that the regulative process is a simple expression of the same processes that are at work in normal development. The marvel is no more, no less, than that of development itself.

These four great groups include many of the most important kinds of adaptive responses shown by organisms. We can not afford, I think, to underestimate their importance. But observe! They all concern the individual; they tell us nothing in regard to the next generation. Yet even here there has been slowly accumulating in reeent years evidence to show that *some* of the external agents that affect the soma or body of the individual may affect the eggs in the ovary of that individual in exactly the same way.

This evidence fails, however, to show that it is the adaptive responses only that take place alike in germ and soma. The evidence indicates at most that certain kinds of external factors may affect soma and germ in the same way, and that these effects apply equally to beneficial, indifferent and baleful results. There is no satisfactory evidence in favor of the view that specific structures produced first in the soma can be transmitted from soma to germ; and least of all is there any evidence that the eggs or the sperms are affected by the psychic experiences of the body. Yet it is this latter idea to which the Lamarckian school has so often appealed. In recent times the Lamarckian has played a losing game. He has been driven from pillar to post and failed to make good many of his claims, which, if true, should furnish the fairest opportunity for demonstration that the whole field of adaptation has to offer.

We find in this connection a significant fact. Nature has not hesitated to insert an unspecialized egg and sperm between every link in the evolutionary series. She seems more concerned in transmitting a material sensitive to external responses than the effects of previous responses themselves.

We are now in a position to attack what is generally conceded to be the central problem of adaptation. It is held that the crucial test of any theory of adaptation is found in those cases where special contrivances exist, that could not have arisen through action and reaction in a causal sense: for example, in many insects the male and female organs of copulation show close adjustments to each other; those of the male having parts that fit precisely corresponding parts of the female. These fittings vary from species to species, and a change in the male finds a corresponding change in the female of the same species. I shall call these lock and key adaptations—structures and functions complete at birth of the organism. It is a consideration of these adaptations that has separated the naturalists as a class from the physiologists, and has drawn the nat-

uralists and philosophers together—for better, for worse.

Many other illustrations will occur to every naturalist: for instance, the instinct of the caterpillar to spin a coccoon that serves as a protection not so much for itself as for the future pupa, the instinct of the spider to make a web to catch a prospective fly, or of a bird to build its nest for eggs not yet in sight; the occurrence of offensive odors or poisons, or of organs that act as a passive defense for the animal as the spines of the hedgehog or of the sea-urchin, or the colors of animals that may at times serve to protect them. Zoologists have, I think, often let their imagination run riot concerning some of these adaptations, but there remains enough that is probable to satisfy the most sceptical.

I have said that we can not afford to underestimate the *directly adaptive* responses shown by the body, and I have intimated that these are only elaborations of already existing functions. Let me add that the naturalist has equally felt that he can not afford to neglect the lock and key adaptations. The alliance between philosophy and biology is due to the fact that these contrivances are not the result of primary, or directly causal relations, but are secondary relations, which appear to be removed from the province of physical problems in the sense that they are supposed *not* to be the result of causal interaction. It is in this aspect of the subject that chance and purpose bloom forth in all of their significance and danger. It is here, therefore, that it is our duty as scientists to make careful inquiry into what causes the lock to vary and what the key and to discover, if possible, whether there exists any mechanism to insure that they shall continue to vary along the same lines.

Perhaps the following somewhat shopworn case may further illustrate my meaning.

The long coiled proboscis of sphinx moths permits them to reach the juices at the bottom of flowers with a tubular corolla. The proboscis is fully formed when the moth emerges from the pupa and its use has no influence in increasing its length. The proboscis is to the corolla what the key is to the lock and yet the lock can have no causal, *i. e.*, direct influence in shaping the key.

If we exclude the Lamarckian explanation, we find many relations of this sort. The speed of the hare bears no causal relation to that of the fox. We can not think of the fox in the sense of a physical environment acting on the germ cells of hares; yet without the fox the hare would, we feel confident, never have developed the long hind legs. In brief, the zoologist has come to look upon contrivances of this kind as the very essence of adaptation. He finds himself in consequence facing two alternatives, neither of which is he anxious to accept. On the one side are the champions of chance; on the other, the apostles of purpose. The issue may *seem* to have reduced itself to these alternatives.

I beg your attention for a little while to consider the import of this decision, and I will take Bergson's view in his "L'Évolution Créatrice" as the clearest and most profound expression of the hypothesis that adaptation of the living world is the outcome of a creative force that shapes matter for an immediate purpose, though not according to a preconceived or predetermined purpose. Many philosophers have assumed a creative principle of some kind that directs the organic world, but have generally taken an anthropomorphic conception of the process. Bergson, on the other hand, conceives of creation without

a creator—he formulates a creative principle that does not postulate the doctrine of finality. His élan vital adjusts itself to each new need that arises; does not work on a preconceived or foreordained plan, but adapts itself to the matter and to the situation in the same way in which an inventor will take the materials at hand and shape them to his purpose with the tools at his command.

It seems to me—I may be wrong—that this theory of the origin of adaptation will not find wide acceptance with the militant evolutionist of to-day; and I shall attempt to formulate the reasons why it seems to me he is likely to refuse to accept so attractive a view, even when so persuasively presented.

In the first place, the theory tells us everything and tells us nothing. It solves the problem by begging the question. An internal principle of which we know nothing steps in like the fairy in the story and does all that is required.

In the second place, Bergson's theory attempts to solve one of the ultimate problems of biology by *a priori* argument—a method from which science has suffered much and has come to look upon askance. Our experience in studying living things teaches us that only by patient labor extending over many years are we likely to gain a little insight into even the simplest modes of action. We feel that there is no royal road to the solution of such complex questions.

And lastly, Bergson's theory, like many of its kind, directs its attention to that side of the problem that is entirely beyond our present ken, namely, the intimate nature of the reaction itself. It lays in consequence on the problem an emphasis that is foreign to our scientific discipline. It may be good philosophy or excellent metaphysics, but it distracts the scientist from his more modest aspirations. It is as though the physicist directed his attention to an explanation of why hydrogen combining with oxygen should give the qualities that we recognize in water; or why the particle of sodium chloride should give a crystal having the form of a cube. If the chemist or physicist disclaims any such ambition, how much more must the biologist disclaim any knowledge—nay, the possibility of any such knowledge, at present, of the behavior of highly complicated organic matter.

If from the point of view of the working evolutionist I have ventured to criticize Bergson's "L'Évolution Créatrice," I beg that you will not understand me to say that I am unappreciative of its value in other directions. On the contrary, as a contribution to speculative metaphysics, it has unusual fascination; as a contribution to that higher form of literary art that we call philosophy, it is an admitted masterpiece. But the day is fast disappearing when the scientific study of evolution can be exploited for literary purposes—except for literary purposes. Paper evolution has fallen into disrepute.

If then we fail to find intellectual satisfaction in the idea that adaptations have arisen as a conscious response of the animal, what alternative does the *theory of chance* offer?

The only legitimate sense in which chance can be applied is, as I have said, that the variations happened, *i. e.*, chanced, to find an environment suited to them. In this sense we speak of evolution as a chance result. Nevertheless, I think most of us feel, as I have said, that there must be some closer bond than chance that insures the *continuance* in a given direction of variations once begun. Even Weismann, a typical neo-Darwinian, admitted in his interesting essay on Germinal Selec-

tion, that unless we can find such a relation, the whole fabric of natural selection falls to the ground; and, as is well known, he attempted to supply this deficiency in his competition of the biophors in the germ-cells. His attempt has failed, on the whole, to bring conviction that the result has been reached in this way, but his statement, in regard to the weakness of the appeal to chance, has, I believe, struck a responsive cord.

It seems to me that we get a suggestion of how continuous adjustment is more likely to occur if we refer variations not to internal conflicts of the biophors, but to the action of external factors on the germ plasm, and *assume* that germinal material that shows itself susceptible of change in an environment is more likely to show further variations in the same direction in that environment.

On some such view we can better understand how evolution along adaptive lines is more likely to give further variations in the same direction, and there is not a little evidence in favor of this view in the history of domesticated animals and plants. After the first step, which was undirected, *i. e.*, not purposeful, the subsequent events are rendered more probable; for the dice are loaded. Evolution along adaptive lines would be a consequence of the very processes that variation has initiated.

The same idea shows how incipient stages of organs may progress until they become of positive advantage to the race and may ultimately carry it along a progressive line of evolution; or should the variation be baleful, lead in its ultimate development to the destruction of the species.

Turning now to another aspect of the subject, I think that our ideas concerning chance and purpose have been largely influenced by those creative processes in which man himself *seems* to have played a leading rôle. I refer to the artificial production of our domesticated animals and cultivated plants.

We owe to Darwin chiefly a comparison between certain features in the development of adaptation under domestication and the development of adaptation in nature.

Domesticated hens lay more eggs than *Gallus bakkiva*. Cows give more milk than buffaloes. Apples in an orchard are larger than in the forest. Potatoes are bigger in a garden than in the wilds of Chili. Why? In part, no doubt, because better conditions of soil or of feeding keep up the product to its maximum, but no one will claim for a moment that the only difference is in the better conditions of food. We realize that the results have not and could not have been obtained from the wild forms at once, but only through a long process of artificial selection by which the domesticated animals have become *adapted* to man's needs.

Admitting this, as one must, what is its bearing on our problem? It is admitted that artificial selection has created nothing new, it has supplied only an opportunity for what already appeared, as new, to remain in existence, but, by picking out the new variation and isolating it under conditions where it can live, *purpose* enters in as a factor, for selection had an end in view.

By preserving the variation the possibility of further variation in the same direction is insured.

We see clearly enough the rôle that chance and purpose play in these processes. The first variation is the result of the environment acting on the organism; it happened, "chanced," to appear at a time when a man was there to give it an opportunity to live. And about its pur-

pose? It could only be said to have purposely *arisen* because it was conscious of a man in its vicinity that would protect it, which is sheer nonsense to most of us. This would mean from Bergson's point of view that cows began to give more milk under domestication because the "élan vital" of the cow made a sacrificial offering to man on the altar of their common interests; that hens laid more eggs on the same altar and that the fancy races of fat pigs have arisen from disinterested or unsophisticated motives so far as the creative principle in the pig is concerned.

But after a new variation had arisen we may speak of purpose as a directive agent in the formation of domesticated races, in the sense that man supplied the purpose when he selected the new variation. The next step was again due to a further action of the environment, but the direction of that action was to some extent prejudiced by what had already taken place. Usefulness to man was the direction in which new variations were made more probable.

Let us see how by adjusting this scheme to nature our alternative of chance or purpose fares. As before, we assume a first variation arises through external factors. If it finds a suitable place it survives. Here there is no purpose unless in the far-fetched sense that finding the external world suited to itself "is a purpose"; rather is the result due to chance. But there is another side to the question from the Darwinian point of view; for, while it is admitted that chance may in some cases have to do with survival as just defined, yet survival is due on the whole more often to *competition;* when the race is to the swift and the battle to the strong. It is for a purpose that an organism crowds out its competitors, for the purpose of survival—not conscious purpose, perhaps, but in a different sense the *result* is purposeful. So I think by a shifting of the angle of vision one might come to look upon survival in nature as purposeful in the same sense in which that term is applied to artificial selection. By this substitution the old and familiar phrase, purpose, might still be applied in a *perverted sense* to the theory of natural selection, and possibly the popular extension of the theory may have been in part due to the easy psychological transition thus afforded.

But does this conception of the evolution of adaptation accord with our experience? Is the battle always to the brave—for the brave is sometimes stupid—or the race to the swift, rather than to the more cunning? Have we here a true picture of the evolution of adaptation?

An individual advantage in one particular need not count much in survival when the life of the individual depends on so many things—advantages in one direction may be accompanied by failures in others, chance cancels chance. Take, for example, the human race, the conditions of which we know perhaps better than those of any other. An individual may be highly gifted in one direction compared with his fellows. He may win a Marathon, or have more intelligence; he may have a better physique, or a more perfect digestion; but he does not therefore necessarily leave more descendants even if his advantages bring material and social rewards. There are no records, so far as I know, to show that we can trace back to only a single pair of superior individuals any preponderating number of individuals of succeeding generations; often the reverse is observed, for the more highly gifted often have fewer offspring. It seems to me that what we know is at variance with the widely accepted interpretation that the individual

through his own advantages replaces by means of his offspring the rest of the population. Rather do we find that the progressive races are those in which the environment causes definite variation in the largest number of advantageous directions. The race advances by the accumulation of these variations. Many individuals of the race contribute towards its maintenance by adding to its advantages, some in one way, some in another. And they do so, not by supplanting their fellows, for each advantage to be gained, but by combining with them. The new variations are the products of the environment. Their perpetuation by grafting on to the race raises the race to a level from which further variations in the same direction are possible. Sexual reproduction comes to have an unexpected meaning, for through it the contributions of the individuals are added to the race. It seems to me that some such interpretation as this is more nearly in accord with our present knowledge of the origin of adaptation. If so, we should expect advance in the human races to take place not by every man's hand being raised against his neighbor, nor by the picking out of a few choice individuals in the way the breeder produces new varieties of corn, horses, pigeons and pigs, but we should expect advance to take place in those parts of the world where there is a good stock to start with, and an environment that calls forth in that stock favorable variations in excess of unfavorable ones.

It seems preposterous to us that so highly organized a machine as the human body could have evolved by undirected variations and chance combinations from a formless mass of living matter. But such a statement of the problem gives a false impression, if, as I have tried to show, each step that the organism has taken guarantees further responses in the same direction. And, since the steps that count are the adaptive ones, the very essence of the process of evolution is such that the organism is carried along adaptive lines. The mechanism of survival (if I may be pardoned the expression) is such that it insures success where it is most called for. To repeat a familiar epigram: In evolution nothing succeeds like success.

In conclusion, I owe you, I fear, an apology for attempting to discuss so serious a theme at this time and occasion, when high living may not be conducive to plain thinking. In the detail of every-day work in which we are plunged we are apt to lose sight of the relative value of the problems at which we work. It seemed to me, therefore, that it might not be inappropriate this evening to focus our attention on the large problem of organic adaptation, which is still, I think, the central problem of the naturalist; and if in attempting an analysis of the present situation I have allowed my imagination too free rein, I submit, in defense, that the human mind has an ineradicable tendency to probe into the unknown, and that the fires of the imagination, kept alive by human curiosity, may also serve a purpose in the progress of human thought, *provided* the imagination is controlled at every advance by an appeal to experience, and is used as a tool and not as an end in itself. But I frankly confess that I feel, as no doubt every one does who tries to keep in touch with modern work, that the time is past when it will be any longer possible to speculate light-heartedly about the possibilities of evolution, for an army of able and acute investigators is carefully weighing by experimental tests the evidence on which all theories of evolution and adaptation must rest. To them belongs the future.

T. H. Morgan
Columbia University

THE MAGNETIC SURVEY OF CHINA

MR. DON C. SOWERS, sent out in November, 1908, by the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, to secure magnetic observations in China and Chinese Turkestan, returned to Washington last December.

Besides the leader, the party consisted of Professor C. G. Fuson, of Canton Christian College, a Chinese interpreter and a cook. Leaving Peking January 30, 1909, they went as far as Honanfu by rail; thence traveling by Chinese carts, pack animals, mule chairs, etc., the party proceeded along the great northern trade route of China, passing out of China proper at the end of the Great Wall in northwestern China, thence across the Gobi Desert to Urumtsi, the capital of Chinese Turkestan. Continuing in a southwesterly direction, skirting the Taklamakan Desert, along the south side of the Tien Shan Mountains, the expedition finally reached Kashgar, in the western part of Chinese Turkestan on July 28. Turning here to the southward the Himalaya Mountains were crossed via the five passes of the Karakorum trade route, the highest trade route in the world, arriving at Leh, India, in September, and at the railroad at Rawal Pindi, northern India, October 13.

The overland journey from the terminus of the railroad in China to the place where the railroad was again reached in northern India was over 4,500 miles in length and required eight and one half months to accomplish it. It lay through a little frequented and, until recent years, unexplored portion of the globe. It is a region full of interest for the geographer, historian and scientist.

The party was everywhere shown the utmost courtesy and every possible assistance was rendered by Chinese officials as well as by representatives of foreign governments.

Connection was made at Dehra Dun with the magnetic survey of India, at present in progress under the direction of the British government.

SCIENTIFIC NOTES AND NEWS

SURGEON CHARLES F. STOKES has been nominated to be surgeon-general of the navy, to succeed Surgeon General Presley M. Rixey, who retires.

ON the evening of April 2, at the Waldorf-Astoria, a dinner will be given in honor of Dr. Charles F. Chandler, head of the department of chemistry of Columbia University, whose resignation after forty-seven years of service will go into effect next June.

THE Geological Society of London will this year award its medals and funds as follows: the Wollaston medal, as already announced, to Professor W. B. Scott; the Murchison medal, to Professor A. P. Coleman; the Lyell medal, to Dr. A. Vaughan; the Wollaston fund, to Mr. E. B. Bailey; the Murchison fund, to Mr. J. W. Stather; the Lyell fund, to Mr. F. R. Cowper Reed and Dr. R. Broom.

THE council of the Royal Geographical Society has decided to award a special gold medal to Commander Peary for his journey to the North Pole, and for having undertaken such scientific investigations as his opportunities permitted; and a silver replica to Captain Bartlett for attaining eighty-eight degrees north latitude. It is expected that Commander Peary will lecture before the society on May 4. Later in the month he will lecture before the Berlin Geographical Society, which will confer on him its gold medal.

PROFESSOR W. BATESON, who vacated a fellowship at St. John's College, Cambridge, on resigning the professorship of biology in the university, has been elected to an honorary fellowship.

MR. JOHN D. ROCKEFELLER, having learned of the distinguished services to medical science which have been and are being rendered by the researches of Professor Paul Ehrlich, of Frankfurt, Germany, has presented to the board of directors of the Rockefeller Institute for Medical Research the sum of ten thousand dollars to be placed at the disposal of Professor Ehrlich for furthering his investigations into the chemical therapy of the protozoon diseases.

THE New York *Evening Post* states that Professors H. N. Morse, H. C. Jones and S. F. Acree, of Johns Hopkins, have received their sixth annual grant from the Carnegie Institution of Washington for the prosecution of

special researches in chemistry. Professor Morse and his assistant, Dr. W. W. Holland, are engaged on the subject of osmotic pressure, especially at higher temperatures. Professor Jones and Dr. W. W. Strong are studying quantitatively the absorption spectra of various solutions. Professor Acree and Dr. B. B. Turner will continue their investigations on tautomerism and the theory of catalysis.

Dr. T. C. Chamberlin, professor of geology in the University of Chicago, has been elected president of the Geological Society of Chicago.

The Chanute Medal, which is each year awarded by the Western Society of Engineers for the best paper presented to the society in the field of civil engineering during the preceding year, has been given to Professor Arthur N. Talbot, of the University of Illinois. Professor Talbot's paper is entitled "Tests of Cast-Iron and Reinforced Concrete Culvert Pipe." The foundation for the medal given by the Western Society of Engineers was established by Dr. Octave Chanute. The arrangement provides for three medals, one for work in mechanical engineering, one in civil engineering and one in electrical engineering.

The council of the Royal Astronomical Society has awarded the gold medal of the society to Professor F. Küstner, director of the University Observatory of Bonn.

Dr. Chas Morrey, head of the department of bacteriology in the Ohio State University, has been given leave of absence for the next academic year.

Mr. W. H. Pew, assistant professor of animal husbandry in the Iowa State College, has declined the directorship of the New Hampshire Agricultural Experiment Station.

A committee has been formed in England, the membership of which includes the Italian ambassador, the Marquis of San Guiliano, Sir Thomas Clifford Allbutt, regius professor of physics at Cambridge, and a number of prominent scientific men and physicians, to promote the investigation and study of pellagra.

Sir Ernest Shackleton has denied the report that he is to lead another expedition to the Antarctic.

Reuter's Agency learns that the first member of the British Antarctic Expedition under Captain Scott, Mr. Cecil H. Meares, has left England. He is going to Siberia to obtain dogs and ponies for use in the expedition. Except that he is to make a brief stay at Moscow, Mr. Meares travels direct to Vladivostock. Thence he will proceed north to the Amur and by means of sledges will press further north to Yakut, a great sable center in Yakutsk, where animals will probably be procurable. Later he may leave to go to Okhotsk and on to the Verkhoiansk Mountains, a region which is described as being almost, if not quite, the coldest in the world. Mr. Meares intends to get most of his dogs, particularly the main team leaders, in Siberia. This part of the work is likely to occupy between three and four months. Mr. Meares will then begin the collection of ponies in the country round Harbin, and, with his animals, will join the main body of the expedition on board the *Terra Nova* in New Zealand in December.

Professor Joseph Jastrow, of the department of psychology of the University of Wisconsin, has accepted the general editorship of a new series of psychological manuals for the general reader, to be known as the "Conduct and Mind Series." His own contribution to the series will be a work on "Character and Temperament." The introduction to an English edition of Professor Gross's "Criminal Psychology," about to be issued as the first number of a series of translations of important foreign works on the subject by the American Institute of Criminology, will be written by Dr. Jastrow. He leaves the university the second week of February to spend the second half year as lecturer at Columbia University.

Dr. Arthur T. Hadley, president of Yale University, will deliver the oration on golden jubilee day, May 17, next, when the fiftieth anniversary of the foundation of the College of California, the precursor of the University of California, will be celebrated.

Professor John Dewey, of Columbia University, gave, at the Johns Hopkins University, from January 31 to February 5, a course

of six lectures on "Aspects of the Pragmatic Movement of Modern Philosophy."

PROFESSOR R. A. DALY, of the Massachusetts Institute of Technology, gave five lectures to advanced students in the Geological Department of the University of Wisconsin in January on the subject of Igneous Rocks.

PROFESSOR CARL RUNGE, of Göttingen, Kaiser Wilhelm professor at Columbia University during the present year, is now giving lectures at several American universities. At the University of Michigan he has given the following course:

February 4—"Methods of Graphical Calculation."

February 5—"The Graphical Representation of Functions" (first lecture).

February 7—"The Graphical Representation of Functions" (second lecture).

February 8—"Graphical Integration and Differentiation."

February 10—"Differential Equations Treated Graphically."

A STATUE of the late Morris K. Jesup, for many years president of the American Museum of Natural History, was unveiled in the foyer of the museum on February 9. The statue, which is of Carrara marble and represents Mr. Jesup seated, is the work of Mr. William Couper. Addresses at the unveiling were made by Dr. Henry Fairfield Osborn, who has succeeded Mr. Jesup as president of the museum, and Mr. Joseph H. Choate, one of the founders of the museum.

THE three great meteorites, brought by Commander Peary from the Arctic regions and for some time exhibited in the American Museum of Natural History, have been purchased and given to the museum by Mrs. Morris K. Jesup.

THE firm of Dr. F. Krantz, of the Rheinisches Mineralien—Contor, Bonn, Germany, has requested Dr. M. E. Wadsworth, dean of the School of Mines of the University of Pittsburgh, to assist the firm in preparing a collection of crystal models to accompany Dr. Wadsworth's recently published laboratory "Manual of Crystallography."

A SERIES of lantern slides especially designed for use by teachers of physical geography has been prepared by Professor D. W. Johnson, of Harvard University. The slides are photographic and contour representations of the same land form on the same slide, the map being so oriented that its bottom is the foreground of the photograph. Many of the views reproduced are from Professor Johnson's own negatives; the rest are from photographs in the Garden Collection of Photographs at Harvard University.

THE Liverpool Geological Society, as we learn from *Nature*, celebrated the jubilee of its first meeting on January 10. The society entertained at dinner the Lord Mayor and representatives of the university, of kindred societies in the city and of the Yorkshire Geological Society and the North Staffordshire Field Club. The toast of the university elicited expressions of regret at the absence of a chair of geology in the university. The first meeting of the society having been held on January 11, 1860, an open meeting was held on January 11, and was largely attended. Mr. W. Hewitt, the president, was in the chair, and the minutes of the first meeting having been read, he remarked that that meeting was held in a room in the house of Mr. G. H. Morton, the first honorary secretary of the society. He also read a letter from Mr. H. Duckworth, the first president, congratulating the society and regretting that his age prevented his being present. Professor J. W. Judd, C.B., F.R.S., an honorary member of the society, then delivered an address on "The Triumph of Evolution: a Retrospect of Fifty Years," remarking that the foundation of the society was nearly coincident with the appearance of Darwin's "Origin of Species."

TWENTY lectures by non-resident lecturers have been arranged by the mechanical engineering department of Columbia University. Charles B. Going, managing editor of the *Engineering Magazine*, will give the first six on February 10, 12, 17, 19, 24 and 26, his subject being "The Province of Works Management." Charles U. Carpenter, president of the Herring-Hall-Marvin Safe Co., will lecture on March 5, 10, 12 and 17, on "The Functions of Organization, its Purposes,

Scope and Object." H. L. Gantt, consulting engineer, will lecture on March 31 and April 2 on "The Compensation of Workmen." Walter M. McFarland, vice-president of the Westinghouse Electric and Manufacturing Co., will lecture on April 7 on "The Importance of the Commercial Elements in Engineering Achievement." Harrington Emerson, consulting engineer, will lecture on "Works Management," on April 14, 16 and 21. Richard T. Lingley, treasurer of the American Real Estate Co., will lecture on "Bookkeeping," on April 30, May 5 and 7. E. J. Prindle will lecture on May 14 on "Patents as a Factor in Manufacturing Operations."

The medical department of the University of Michigan offers the following list of lectures as extramural university extension work. The same lectures are also delivered during the course of the year, during the summer school to university students and town's people of Ann Arbor, and are delivered anywhere in the state of Michigan under the conditions mentioned in the medical calendar.

"The Evolution of the Superman: The Fight against Tuberculosis," by Dean V. C. Vaughan.

"Medicines: Their Use and Abuse," Professor Edmunds.

"Psychotherapy," Professor Camp.

"The Prevention of Insanity," by Professor Barrett.

"The Rôle of Insects in the Transmission of Disease," by Professor Novy.

"The Prevention of Tuberculosis; the Venereal Diseases and their Extermination," by Professor Warthin.

"Development as an Aid in the Interpretation of Structure," by Professor Huber.

"The Care of the Eyes in Children," by Professor Parker.

"The Problem of Pure Milk; Children's Diseases," by Professor Cowie.

"The Prevention of Premature Old Age," by Professor Hewlett.

"The Cancer Problem," by Professor Peterson.

In accordance with a request of the Chilean government, transmitted through the customary diplomatic channels, the commissioner of education calls attention to the announcement of an Exposition of Fine Arts to be opened at Santiago, Chile, on September 18, 1910, as a feature of the Chilean centennial. This exposition will be held in the recently erected Palace of Fine Arts which will form a permanent memorial of the occasion. Works of art intended for this exposition must be forwarded before the first of May of the present year. Full particulars with respect to the plans for the exposition may be obtained by addressing the general secretary, Mr. Ruchon Brunet, Santiago, Chile.

The London correspondent of the *Journal* of the American Medical Association writes that the prohibitive price of radium has led to the establishment of a novel institution—a radium bank where the precious metal may be stored and rented to physicians, scientists and others who wish to use it but can not afford to pay $80 a milligram, its present market price. The ultimate locality of the bank is to be in the neighborhood of Cavendish Square, in the heart of the district in which London consultants live, but for the present temporary offices have been opened at Moorgate street in the heart of the commercial and banking district of the city. For an average operation 50 milligrams of radium are required, costing $4,000 and, therefore, it is only at one or two of the London hospitals that radium can be used to any extent. A number of business men have combined to form the bank which will "let" 100 milligrams at $200 for one day's use and for each subsequent day at one half per cent. on the value of the amount issued. Securities will have to be given. The bank purposes to stock radium to the value of $250,000. The difficulty is in getting a supply of radium. The main source has been the pitch-blende from Joachimsthal, Bohemia, which yields one part in 3,000,000. A new supply has been discovered in the bed of a stream near Guarda in Portugal. In England two Cornish mines have yielded a little but the whole available supply is limited owing to the enormous expense of extraction. Although radium exists in air, sea water and almost everywhere, there is hardly an ounce of the pure metal in the world. The bank will be organized very much

after a model of a similar institution in Paris, through which most of the radium used in England has hitherto come.

THE Institute of Chemistry is issuing, as we learn from the London *Times*, the third edition of the "List of Official Chemical Appointments," prepared by its secretary and registrar, Mr. Richard B. Pilcher. The work is intended primarily for the use of professional chemists and those who contemplate making chemistry their profession, but it should prove useful also to those who are interested in the applications of chemistry to the purposes of the state and in the promotion of higher education in the science. It is arranged in three divisions. The first gives official appointments in Great Britain and Ireland under the various departments of state, local authorities and public institutions and teaching appointments in the universities, colleges, technological institutions, medical, agricultural and veterinary colleges and public and secondary schools. The second contains similar information for India, Australia, New Zealand, British South Africa and British colonies and protectorates, with Egypt and the Sudan; while the third gives a concise account of societies and institutions devoted to the advancement of chemical science and of professional chemical interests.

THE College of Mechanical and Electrical Engineering of the University of North Dakota has secured additional quarters 170×40 feet in which will be located the steam, gas and electrical engineering laboratories and the iron foundry. The new engine room is to have as a part of its equipment a 70 horse power automatic cut-off high speed steam engine, two 25 kilowatt electrical generators, a 12 horse power gasoline engine, and a 55 horse power producer gas engine. The new boiler-room will have three 70 horse power fire tubular boilers. These last are of the same make and each will be provided with different type of furnace and different grates. One will be equipped with an automatic mechanical stoker, another with a special combustion chamber, while the third will have the furnace usually installed with this type of boiler. The college will undertake to determine the relative efficiency of the different types of furnaces in burning any given fuel and to determine also the relative steaming qualities of different fuels when burned in the three distinct types of furnaces. In the boiler room a 50 horse power suction down-draft gas producer designed to handle lignite and soft or bituminous coals. With certain modifications it can be converted into an up-draft gas producer capable of handling anthracite and coke. In selecting the power equipment it is the idea of Dean Crouch to install such apparatus and machinery as will enable the college to investigate the best ways and means of utilizing North Dakota lignite (in which the state abounds) and of converting the same into power. That the results obtained may have a practical value, the units selected are of sufficient size to give fair indications of what may be expected from commercial plants. The experimental engineering laboratories are supplied with various types of electrical generators, motors, transformers, etc., and are equipped for testing all kinds of steam, gas, hydraulic and electrical machinery. The iron foundry is being equipped also with a cupola with a melting capacity of two tons an hour.

THE following data have been compiled by Messrs. Waldemar Lindgren and H. D. McCaskey as a preliminary review of the gold industry in the United States in 1909. Gold mining progressed, on the whole, very satisfactorily in 1909. The year was marked by increasing recovery from the depressed conditions of the two years immediately preceding and by general advance in the development of proved mines and districts. Although these improvements resulted in a generally increased production of the base metals, and as a consequence augmented the gold output, they did not seriously detract from those gold-mining operations which had benefited during the late panic by the closing of numerous copper, lead and zinc mines and the consequent release of skilled labor for gold mining. From the preliminary figures of the Director of the Mint, which have just been published, it is estimated

that the output of gold for 1909 reached the unprecedented total of $99,232,200, an estimated increase of $4,672,200 over the production for 1908. In spite of serious drawbacks, first in one mining camp, then in another, the production of gold has increased more than $4,000,000 in each of the last two years, and the outlook indicates, unless present abnormal conditions in the Black Hills should continue or curtailment be shown elsewhere, a production of over $100,000,000 in 1910. In general, gold production has increased mainly from placers and the mining of siliceous ores, and to a smaller degree from copper ores, from which gold is a by-product. According to estimates from the Bureau of Statistics, the United States imported in 1909 gold valued at $13,510,513 in foreign ore, $26,233,368 in foreign bullion and $6,059,313 in foreign coin, and exported gold valued at $498,822 in domestic ore, $43,021,545 in domestic bullion, $86,803,265 in United States coin and $2,717,725 in foreign coin, the excess of exports over imports thus being $87,238,323. In 1908 there was an excess of exports over imports valued at $30,939,163. The imports in 1909 were made up chiefly of ore and bullion from Mexico and to a smaller degree from Canada and South America. The exports consisted largely of coin and went chiefly to South America, though large amounts of gold were sent to Japan, the United Kingdom and France.

A REPORT on the annual exports of farm products from the United States from 1851 to 1908 from the Bureau of Statistics, U. S. Department of Agriculture, gives averages by five-year periods, so that it is possible to perceive the general drift of the trade. The chief agricultural products exported in the past half century have been (1) cotton, (2) grain and grain products and (3) packing-house products. In 1851–5, cotton made nearly two thirds of the value of all agricultural exports, but in 1901–5 between one third and one half only, although the average quantity exported increased from 1,026 million pounds in 1851–5 to 3,577 million pounds in 1901–5, while in 1907, the highest year, 4,518 million pounds were sent out. In the period 1861–5 the quantity of cotton exports was only about 5 per cent. of that for 1856–60. Increases occurred afterward, however, until in 1876–80 the average quantity exported was somewhat greater than in the period just prior to the Civil War. In quantity exported per capita, the five-year period 1856–60 was highest; there were then exported 44.8 pounds of cotton per capita. The nearest approach to this was 44.5 pounds per capita in 1901–5. Cotton-seed products, such as cotton-seed oil, oil cake and oil-cake meal have assumed considerable importance in the export trade of the United States in recent years, that is, beginning about 1876. The value of cotton-seed products exported averaged during the past several years from 25 million to 30 million dollars a year, the highest being in 1907, about 34 million dollars. Grain and its products come second in order of value. They increased from a yearly average of 25 million dollars in 1851–5 to 194 million dollars in 1901–5, in 1851–5 to 194 million dollars in 1901–5, and in 1908 were 215 million dollars. The chief items are wheat (including wheat flour), corn and oats. Exports of these cereals during 1851–5 were equivalent to about 20 million bushels of grain annually, and fifty years later to about 250 million bushels. The period of largest grain exports was 1896–1900, since which time there has been a decline. The per capita exports of wheat and flour were largest in 1881–5, when they were equivalent to 2.6 bushels per capita; in 1901–5 the average exports per capita were 2 bushels, and since 1905 have been less than 2 bushels. In corn the maximum limit was reached in 1896–1900, when an average of 2.4 bushels per capita was exported. Then came a downward tendency, the exports in the next five-year period being only 1.1 bushels per capita, and in succeeding years falling below 1 bushel. Compared with corn and wheat, exports of oats have been small, the largest average for any five-year period being 38 million bushels a year during

1896–1900, or something more than one fifth the corresponding exports of corn or of wheat, including flour. Exports of packing-house products, a third leading group, have increased much more rapidly in the last half century than cotton or cereals. The average value of packing-house products exported in 1851–5 was 10 million dollars a year, and in 1901–5 it was 183 million dollars, while in 1908 the value was 196 million dollars.

A STATEMENT received at the Department of Agriculture from the Forest Service office at Portland, Oregon, shows that the timber sales on national forests in the Pacific northwest is increasing rapidly. This increase is regarded as an index of the revival of business in the lumber industry generally, and shows also the growing use of national forest resources by the public. The contrast between the amount and value of timber sold during the last six months of 1909 and that sold during the corresponding period in 1908 is marked. The figures are for most of the national forests in Oregon and Washington, and show timber sales of over 52 million feet, for nearly $114,000, during the last six months of 1909. This compares with sales of about 17 million feet, for a total of $27,000, during the same period in 1908. The prospects for the coming six months are regarded as promising even better than what has been realized in the period just past. This increasing timber sale opens the way to management of the national forests along the best lines by permitting the removal of over-mature and decadent timber which has practically come to a standstill in point of growth, and allowing replacement of these trees with a fully stocked stand of rapidly growing young trees.

THE topographic survey of the Mount Baker quadrangle, in the state of Washington, was completed last fall by members of the United States Geological Survey and the resulting map is being prepared for engraving. The party that made this survey was under the direction of J. E. Blackburn and in the course of the work Mr. Blackburn, with E. H. Jones, T. L. Duncan and C. V. Guerin, climbed Mount Baker, from whose slopes and summit observations were made and mapping was done. The whole mountain is an almost unbroken glacier, only narrow rocky dikes protruding here and there through the vast ice mass. This glacial ice, constantly augmented by snowfall, accumulates in a number of huge gorges, forming glaciers that move down the mountain's sides for several miles before melting. Thus the ends or lower boundaries of the glaciers are about 3,700 feet above sea level, whereas the altitude of the dome of Mount Baker is 10,745 feet. The climb to this summit was made in four hours by the topographic party from its last camp, which was pitched at an elevation of 5,200 feet. Mount Baker was long ago one of the active volcanoes of the Cascade Range, and the steam issuing from the sulphur-lipped vents of its crater today show that its internal fires are not yet entirely dead. The crater is about 1,000 feet below the main dome of the mountain. The summit is a table having an area of about sixty acres. Besides Mount Baker, this quadrangle contains many other majestic mountains. Notable among them is Mount Shuksan which rises abruptly from the canyon of the North Nooksak and terminates in a spire 9,038 feet above the sea. This mountain, although only a few miles distant from Mount Baker, is isolated, and its peculiar structure causes difficulties in making an ascent. Besides these two conspicuous mountains, other peaks along the summit of the Cascade, on the eastern edge of this quadrangle, rise to elevations above 6,000 feet, and, when seen from a distance, the panorama of the Cascade Range presents many views of extreme beauty and rugged grandeur. The mountains in this region are snow-capped throughout the summer, and the snows of the early fall and winter form reservoirs that feed Skagit River, which is probably the largest stream in northwestern Washington. Last December several days of rain and snow followed by chinook winds produced a flood in the Skagit that submerged the plains in its delta region and caused damage amounting to more than a million dollars.

UNIVERSITY AND EDUCATIONAL NEWS

The Sheffield Scientific School of Yale University has received from Messrs. George G. Mason and William S. Mason $250,000 for a laboratory of mechanical engineering.

For the establishment of the George Peabody College for Teachers at Nashville, Tenn., the sum of $1,000,000 has now been given by the board of trustees of the Peabody Fund for the Advancement of Education in the South. This gift was promised some time ago conditional on the granting by the state of Tennessee, the county of Davidson and the city of Nashville of a sum approximating $750,000.

Additional gifts amounting to $450,000 to seven institutions were announced after the seventh annual meeting of the General Education Board held in New York City on February 2. These are the appropriations: Williams College, Williamstown, Mass., $100,000 on condition that the college raise an endowment of $1,000,000; Wesleyan University, Middletown, Conn., $100,000 toward $1,000,000; Cornell College, Mount Vernon, Ia., $50,000 toward $200,000; St. Lawrence University, Canton, N. Y., $50,000 toward $200,000; Georgetown College, Georgetown, Ky., $25,000 toward $100,000; the Women's College of Brown University, Providence, R. I., $50,000 toward $200,000; the Salem College for Women, Winston-Salem, N. C., $75,000 toward $300,000.

The trustees of the bequest of $2,000,000, left by Mrs. Amanda W. Reed, are, as has already been announced, about to establish a college at Portland, Ore., to be known as Reed Institute. Dr. J. H. Tufts, head of the department of philosophy at the University of Chicago, has recently spent some time in Portland on the invitation of the trustees, to advise as to the scope of the institution.

A medical library of 1,100 volumes has been given to the medical school of the University of Wisconsin by Dr. Byron F. Robinson, a graduate of the university in the class of 1878, now professor of gynecology and abdominal surgery in the Illinois Medical School.

According to the *Madras Educational Review*, as quoted in *Nature*, Sir F. D. Lugard, the governor of Hong Kong, has reported to the British government that Mr. H. N. Mody has offered to present the colony with the building necessary to start a university. A committee has been formed, with the governor as chairman, to promote the undertaking. Mr. Mody's original offer was to give a sum of £30,000 for this purpose and a further £6,000 towards the endowment. Plans of the necessary buildings were prepared, and as the director of public works estimated that the cost would not be less than £58,000, Mr. Mody undertook to provide them in accordance with the plans, stipulating, however, that he should use on the buildings the £6,000 originally given for endowment if it should be required.

Albert Johannesen, Ph.D. (Johns Hopkins), of the United States Geological Survey, has been appointed assistant professor of mineralogy and petrography in the University of Chicago.

Dr. Charles C. McFarlane, principal of the Brockport State Normal School, and formerly professor of geography, has been appointed to the newly-created office of comptroller in Teachers College, Columbia University.

Mr. R. C. Punnett, superintendent of the Museum of Zoology at Cambridge University, has been elected to the professorship of biology recently vacated by Professor W. Bateson.

DISCUSSION AND CORRESPONDENCE

THE SOUTHERNMOST GLACIATION IN THE UNITED STATES

In a recent number of Science[1] H. W. Fairbanks and E. P. Carey report evidences of "Glaciation in the San Bernardino Range, California," in latitude about 34° 7′ N. Concerning this interesting discovery the writers say: "it has hitherto been assumed that the southernmost point of glaciation in the United States was in the Sierra Nevadas, nearly two hundred miles to the north" (north of latitude 36° N.). If their observations are correct, they have found the most

[1] January 7, 1910.

southern instance of satisfactory evidence of glaciation in this country, so far as I recall; but there are several records of glaciation farther south than the point in the Sierra Nevada referred to by them. Brief references to these may be of interest.

SCIENCE for November 22, 1901,[2] contained a "Note on the Extinct Glaciers of New Mexico and Arizona," by George H. Stone, in which he reported evidences of glaciation in one of the Rocky Mountain Ranges "as far south in New Mexico as a point not far north of Santa Fé" (latitude about 35° 41′). In a later paragraph we read:

> The farthest south and west I have found traces of extinct glaciers is at Prescott, Arizona. Around Prescott are numerous moraines. The highest part ot the névé of this glacier could not have been much above 9,000 feet. The central part of the glacier is approximately in n. lat. 34° 30′. The occurrence of an ancient glacier so far south as this was probably due to a very great snowfall owing to the proximity of the ocean. . . . Probably there were then small glaciers in some of the cirques of northern exposure among the mountains directly southeast of Prescott.

R. D. Salisbury published an article on "Glacial Work in the Western Mountains in 1901," in volume 9 of the *Journal of Geology*, 1901. Beginning with page 728 is a brief description of glacial features in the mountains near Santa Fé, between 35° 45′ and 36° north latitude. Some 50 cirques were found, and about 80 ponds and lakelets. One of the glaciers had a length of seven miles. Moraines, striæ and roches moutonneés were observed. In 1902 I had an opportunity to visit this same region, and I entertain no doubt as to the ample proof of local glaciation in those mountains.

In the *Journal of Geology* for 1905[3] is a paper by Wallace W. Atwood on the "Glaciation of San Francisco Mountain, Arizona." This writer describes and figures terminal and lateral moraines, and an outwash plain, and reports the occurrence of striated boulders and polished and grooved bedrock. I have briefly mentioned evidences of glaciation on this same peak, attributing a somewhat greater amount of erosive work to the glacier than is recognized by Atwood, and mentioning what I then believed to be a terminal moraine located near the mouth of a cirque.[4] The latitude of San Francisco Mountain is about 35° 21′ N.

F. J. H. Merrill reports in SCIENCE for July, 1906,[5] "Evidences of Glaciation in Southern Arizona and Northern Sonora." In the vicinity of Nogales, and elsewhere, were found deposits which he believed to be of glacial origin, while the surface had "the rolling topography and pitted surface of a moraine." Nogales is in latitude 31° 20′ N.

The above references may be but a partial list of the published reports of glaciation south of the point in the Sierra Nevada referred to by Fairbanks and Carey; I have made no effort to prepare a complete list. Of these reports, the one on glaciation near Nogales is the most striking, because of the low latitude and low altitude in which the deposits are found. The evidence as reported does not appear sufficiently convincing, in view of the strong probabilities against the occurrence of glacial deposits in the region in question. Merrill's descriptions suggest a landslide origin for the deposits which he took to be glacial. With reference to the glaciation of San Francisco Mountain I wish to add the following paragraphs.

On my visit to San Francisco Mountain I ascended the volcano by the northwest slope, and I descended into the northwestern part of the "crater." I was impressed with the cirque-like form of the depression, and came to the conclusion that the original crater had been destroyed by stream and glacial erosin, and that the encircling cliffs were to be regarded as cirque-walls rather than as crater-walls. The great central depression of the volcano consisted of several more or less distinct cirques uniting downstream. Near the mouth of one of these was what I interpreted as a crescentic terminal

[2] Vol. 14, p. 798.
[3] Vol. 13, p. 276.
[4] *Technology Quarterly*, Vol. 19, p. 410, 1906.
[5] Vol. 24, p. 116.

moraine, rising 150 feet or more above the valley floor. But there were certain associated features which puzzled me at the time. Upstream from the supposed moraine the floor of the cirque appeared to be deeply buried by an accumulation of rock débris which was generally as high as and near the head of the cirque distinctly higher than the morainal ridge. This débris was in places, especially near the marginal walls, arranged in parallel ridges trending with the axis of the valley; and in the depressions between the ridges were patches of snow and some small ponds. Thus the moraine had a steep frontal slope, but at the back merged with the ridged rock débris which rose to still higher levels. There were some depressions in the rock débris, 25 to 40 feet deep, which I took to be ice-block holes. No bedrock was seen in the cirque floor.

During the recent meeting of the Geological Society of America, Professor H. B. Patton, of Boulder, Colorado, exhibited some photographs of the rock streams of Veta Mountain, Colorado. One of these photographs showed the high and steep front terminus of a rock stream, and resembled very closely the front slope of the supposed moraine in the San Francisco cirque. Others of his pictures showed the longitudinal parallel ridges which characterize some rock streams, with bands of snow lying in the hollows between the ridges, just as was the case in the San Francisco cirque at the time of my visit. If the concentric wave-like ridges pictured by Howe[6] were present in the San Francisco deposits, I did not notice them.

I am inclined to believe that the features which puzzled me at the time of my visit may have been due to landslides or rock streams. This does not mean that the depression in which the features occur is not a glacial cirque; nor that the moraines reported by Atwood are not true moraines. It simply means that I am not wholly satisfied with the evidence of glaciation as reported by myself. It would seem that the possibility of a landslide or rock stream origin for features apparently due to glaciation must be carefully considered, especially when glaciation in doubtful localities is involved.

D. W. Johnson

[6] "Landslides of the San Juan Mountains," U. S. G. S. Professional Paper, No. 67.

THE TEACHING OF ELEMENTARY DYNAMICS IN THE HIGH SCHOOL

To the Editor of Science: I have just finished reading "The Teaching of Elementary Dynamics in the High School," by Wm. Kent. I believe that Mr. Kent is right in most respects except his last paragraph, where he states: "It is high time they [teachers of physics in the high schools] change their methods and try the method that was successfully used fifty years ago." As one of the physics teachers in secondary schools, I wish to say that my own practise for many years has not been materially different from that of Mr. Kent and I wish to put in just a word for the most of the physics teachers of my acquaintance when I say that their practise and that of Mr. Kent do not differ in any essential particular.

Again and again the discussion of the *force* $=$ *mass* $\times$ *acceleration* formula has come up among groups of teachers and, in every case, the verdict of the teachers has been that it was not a formidable matter. Each knew a way to teach it so that the pupil got the gist of the matter even if he could not write a text-book on it afterwards. And this is true whether the instruction is given in English or metric units. One is as easy as the other.

Mr. Kent has evidently assumed from the large amount of discussion on this question of dynamics (kinetics) that there is something radically wrong with the teaching of secondary school physics and that the chief cause of any lack of efficiency is to be laid at the door of that one little formula—$f = ma$. We all may easily observe that those who are doing the teaching are not the ones who are doing the talking. It might be as readily discovered that the great majority of teachers are going ahead in a reasonably sensible way and are teaching physics (and other subjects as well) according to the dictates of common sense

without undue regard to "requirements" of any kind.

All *teachers* of physics, whether in the secondary school or the college are under great obligations to Mr. Kent for his clear, excellent and simple explanation of this debated subject.

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NOTE ON FREE PUBLIC MUSEUMS

WHILE reading Mr. Henry L. Ward's very excellent paper on "Modern Exhibitional Tendencies of Museums of Natural History and Ethnology designed for Public Use," recently published,[1] the following interesting statement was noted:

> In fact, to the best of my knowledge, the Public Museum of the City of Milwaukee was the first institution of this nature to throw open its doors for the free admission of the public on every day of the year, a regulation to that effect having been adopted and put into force in December, 1905.

It is exceedingly gratifying to note that this progressive institution has been among the first to recognize that public museums are for the people and that all should be admitted freely with as little hindrance as possible. In this commendable movement, however, the Chicago Academy of Sciences has about ten years' priority over the Milwaukee Museum, its doors having been continuously open to the public since October 1, 1894. The hours are 9 A.M. to 5 P.M. week days and 1 to 5 P.M. Sundays. It is interesting to note that the Willner bequest of $100,000 recently received by the academy was won because the children were allowed free access to the building, especially on Sunday afternoons, and were given more or less attention. Mr. Willner once said to a friend, as he observed the interest of the children in the museum exhibits, "I think this institution is deserving of support." The fact that the academy received one third of his fortune is ample evidence that he believed in the educative value of institutions of this character.

FRANK C. BAKER

[1] Trans. Wis. Acad. Sciences, Arts and Letters, XVI., pp. 325–342, 1908.

SCIENTIFIC BOOKS

The Theory of Electrons and Its Applications to the Phenomena of Light and Radiant Heat. By H. A. LORENTZ.

This book is based upon the course of lectures delivered by Professor Lorentz at Columbia University in March and April, 1906. But the author has introduced into the book considerable material not given in the lectures and has also given in the form of notes many mathematical proofs which were omitted in the lectures.

It was naturally expected that this book by an author, who is himself responsible for a large part in the remarkable development of the modern theory of electrons, would prove of absorbing interest to physicists and to those in general who have any knowledge of the importance and fascination of the subject. As was expected, this is the case.

The author states in his preface that he is perforce obliged to restrict himself greatly in discussing the applications of the theory as to the number of topics considered, and remarks that the work of Voigt on magneto-optical phenomena, of Planck on radiation and of Einstein on the principle of relativity, has not received the attention which its importance would justify. The scope of the book will to some extent be revealed in the present brief review.

In the first chapter the fundamental formulæ of the electron theory are derived from Maxwell's well-known theory, with the aid of auxiliary hypotheses which the nature of the subject demands. Referring to Maxwell's equations, the author calls attention to the fact that, while they are useful and adequate in the treatment of many problems, there are yet many problems for which they are not. He goes on to say:

> Moreover, even if they were so, this general theory, in which we express the peculiar properties of different ponderable bodies by simply ascribing to each of them particular values of the dielectric constant, the conductivity and the magnetic permeability, can no longer be considered satisfactory when we wish to obtain a deeper insight into the nature of the phenomena. If we wish to understand the way in which electric and magnetic properties depend on the temperature,

the density, the chemical constitution or the crystalline state of substances, we can not be satisfied with simply introducing for each substance these coefficients, whose values are to be determined by experiment; we shall be obliged to have recourse to some hypothesis about the mechanism that is at the bottom of the phenomena. It is by this necessity that we have been led to the conception of electrons, *i. e.*, of extremely small particles, charged with electricity, which are present in immense numbers in all ponderable bodies, and by whose distribution and motions we endeavor to explain all electric and optical phenomena which are not confined to the free ether.

After the development of the fundamental equations, the first chapter is chiefly devoted to the general properties of free electrons. Use is made of the quantity named by Abraham the electromagnetic momentum and employed by him in his "Prinzipien der Dynamik des Electrons." The interesting question of the electromagnetic mass of the electron receives comprehensive treatment, in which the necessary distinction between "longitudinal" and "transverse" mass is very clearly brought out. With a view to their subsequent application in connection with the influence of the earth's motion upon optical phenomena the fundamental equations for a moving system are derived. The chapter closes with a brief review of Drude's theory of the conduction of electricity in metals, and of a revised form of this theory, proposed by the author, and considered by him to be somewhat more rigorously developed than that of Drude.

In the second chapter the subject of emission and absorption of heat is discussed from the standpoint of electron theory, with the view of indicating how far this theory may lead toward the elucidation of the mechanism involved in the phenomena.

Reference is made to the classical work of Kirchhoff, Boltzmann and Wien in connection with black body radiation, and it is remarked that the results obtained by Boltzmann and Wien represent all that could be expected from the methods of thermodynamics and general electromagnetic theory, and that these results afford small clue to the discovery of the real nature of the mechanism of emission and absorption.

Planck's theory of radiation is then discussed. As is well known, this theory is based on the assumption that every ponderable body contains a very large number of electromagnetic resonators. Different resonators may have different natural frequencies. In order to arrive at his well-known radiation formula, Professor Planck assumes that each resonator possesses the peculiar property of being able to receive or give up energy in definite finite amounts only, and not gradually. Many who have attempted to follow Professor Planck's arguments in the development of his theory have found their chief difficulty in this assumption. In view of this fact, the concluding remarks of the author are of particular interest. Referring to Planck's theory, he says:

> Yet, we can not say that the mechanism of the phenomena has been unveiled by it, and it must be admitted that it is difficult to see a reason for this partition of energy by finite portions, which are not even equal to each other, but vary from one resonator to another.

Professor Larmor in the Bakerian lecture of November 18, 1909, referring to Planck's theory, also calls attention to the same difficulty.

The author goes on to develop an electron theory of radiation for metals, and arrives at a formula, valid for long waves, which is in agreement with Planck's for this case.

Finally, Jeans's theory of radiation is briefly reviewed. This theory, as is well known, is based on the assumption that the mechanical theorem of equipartition of energy is applicable to modes of vibration in the ether, and it furnishes a radiation formula which for long waves also agrees with Planck's for this case. The author's concluding remark is again of much interest:

> I shall conclude by observing that the law of equipartition which, for systems of molecules, can be deduced from the principles of statistical mechanics, can not as yet be considered to have been proved for systems containing ether.

Professor Larmor in the lecture referred to above refers to the well-known controversy concerning this matter.

Chapters III. and IV. are devoted to an extended discussion of the Zeeman effect and of the propagation of light in a body composed of molecules. In concluding, the author remarks on the inadequacy of the theory in its present state, and cites the experiments of Wood on sodium vapor, and those of Humphreys and Mohler indicating the shifting of spectral lines by pressure, as beyond the power of the present theory to explain.

In chapter V. optical phenomena in moving bodies are considered. Fresnel's classical work in this connection is reviewed, likewise Stokes's theory of aberration with Planck's well-known amendment. The theory of electrons is applied to the deduction of Fresnel's coefficient. The Michelson-Morley experiment is discussed, and its negative results explained on the assumption of the Fitzgerald-Lorentz shortening effect. The negative results of Rayleigh and of Brace in looking for double refraction due to the Fitzgerald-Lorentz shortening effect are explained on the author's theory of corresponding states for a fixed and moving system. Abraham's results on the energy of a moving electron are discussed. The question of form of the moving electron is also considered; and the difficulty is brought out of reconciling the rigid spherical electron of Abraham, or the electron deformed by motion into an ellipsoid having the original volume, proposed by Bucherer and by Langevin, with the experiments of Rayleigh and of Brace on double refraction in moving bodies. The author's well-known electromagnetic equations for a moving system are derived, and the interpretation which has been given to his results by Einstein in the theory of relativity is clearly brought out.

Even the non-mathematical reader will not find unusual difficulty in reading this book. For the text itself is devoid of intricate mathematical proofs. Those who are interested in following through the analysis involved in the demonstrations of the formulæ employed in the text are referred at the appropriate times to the mathematical notes at the end of the book. Throughout, the reader meets with the usual clear methods of exposition so characteristic of all the author's writings. The book is in English and published by the firm of B. G. Teubner, Leipzig.

A. P. WILLS

Taschenbuch für Mathematiker und Physiker. Unter Mitwirkung von FR. AUERBACH, O. KNOPF, H. LIEBMANN, E. WÖLFFING, u. A. herausgegeben von FELIX AUERBACH. 8vo, pp. xliv + 450. Leipzig und Berlin, Teubner. 1909. 6 Marks.

While the chemists, astronomers, engineers and other professional orders have long possessed pocket manuals for handy reference, a similar convenience has not been provided for mathematicians and physicists. The present little volume supplies this want in a considerable degree, and compresses into a small space a remarkable mass of useful information. The "Taschenbuch" will be issued annually, with constant variation of subjects treated so as to cover eventually as wide a range as may be desirable. The first volume, for 1909, has been delayed by circumstances incident to a new undertaking, but future issues are expected to appear early in each year.

A brief notice of Kelvin's work, accompanied by a portrait, opens the volume. There follow a calendar for the year 1909, several useful tables of astronomical, geographical and other constants, and four-place tables of logarithms, trigonometric and hyperbolic functions, squares and Bessel functions. These conclude the introduction, pages i–xliv. The body of the manual is divided between Mathematics, pages 1–160; Mechanics, pages 161–203; Physics, pages 204–350, and General Chemistry, pages 351–369. Later come lists of mathematical and physical journals and of recent publications, a necrology, the roll of teachers in the higher German institutions of learning and a good index of the volume.

Subjects reserved for treatment in later issues are indicated in the text. Under Mathematics are at present included the fundamentals of arithmetic, theory of numbers, algebra, determinants, theory of groups, infinite series, differential and integral calculus, definite integrals, differential equations, calculus of

variations, theory of functions, elliptic functions, geometry and trigonometry, analytic geometry of plane and space, differential geometry, probabilities, calculus of errors, quaternions and vector analysis. Under each of these and other topics is a brief summary of the subject, often containing items that are not elsewhere so easily found.

Mechanics and Physics cover a wide range: Lagrange's equations, spherical harmonics, graphical statics, work and energy, hydrodynamics, elasticity, heat, sound, light, electric units, laws and measurements, electromagnetism, induction, hysteresis, Maxwell's theory, etc. Numerous tables accompany the text.

In arrangement and style the "Taschenbuch" reminds one of Pascal's "Repertorium of Higher Mathematics." It is, however, only about one third as large, and in mathematical content only one ninth. All references have been excluded under the heavy compression. But every mathematician and physicist will find it a useful book to have about, for it will often save searching through a library for an elusive item.

F. N. Cole

Vergleichende Anatomie der Wirbeltiere. Dr. Robert Wiedersheim. Seventh edition. Pp. 936, 476 figures, one plate. Jena, Gustav Fischer. 1909.

The rapid growth of this book, which now contains nearly a thousand pages and costs between five and six dollars, has transformed it from a text-book into a reference work. As such it will without doubt be as indispensable as in previous editions. It retains, however, much the same character as before.

It is pleasing to an American to note the large recognition of American work, but one regrets that in one or more instances the facts are recorded in footnotes only.

The text is brought up to date by the addition of new material on almost every page and certain sections are essentially rewritten, as for example, the discussion of the lymphatic system, which is more than twice as large as before. The chapter upon the skull has grown the most owing to a large degree to the introduction of more figures of chondrocrania. The section upon myology ought, it seems to the writer, to have received more attention than it has had. The subsection upon the electrical organs certainly ought to have been rewritten so as to embody recent discoveries. The sections upon the central nervous system, sense organs and the respiratory system have expanded about equally. The discussion of the peripheral nervous system is but slightly longer, but it has been largely rewritten and is greatly improved.

The sixty new figures are well chosen. A considerable number of illustrations which have appeared in several editions could well be dispensed with, and the printing of many of the old figures in colors has added little if at all to the usefulness or beauty of the book.

The bibliography has been thoroughly revised, a very large number of new titles have been added, and, owing to the omission of many of the older or less important titles, there has been only a small increase in size.

This edition can be heartily commended.

Leonard W. Williams

Lectures on the Experimental Psychology of the Thought-Processes. By Edward Bradford Titchener. New York, The Macmillan Company. 1909. Pp. xi + 318.

In these lectures, originally delivered at the University of Illinois in the spring of 1909, and now published with an appendix containing valuable notes and references, Professor Titchener presents a résumé and criticism of a much-debated recent development in experimental psychology—an attempt to extend the experimental method to the processes of thinking. The extended series of articles which are chiefly considered—though contributions by other psychologists receive due notice—have emanated from the pupils and colleagues of Professor Külpe at Würzburg. The principal names are Marbe, Watt, Ach, Messer and Bühler, and the dates run from 1901 to 1908. Many other writers, whose work or views bear on the problem, are considered in the notes or in the two introductory lectures.

The early experimental psychologists considered the higher intellectual processes too

complex for experimental control, and it is of interest to discover whether this early judgment is now superseded, and whether, quite apart from results, a method has been devised for experimenting on thought. The method now suggested is certainly direct and obvious. The person whose mental processes are to be observed is given a problem to solve; in some experiments the problem has been of the easiest, in others it has demanded careful attention; but in all cases it has been such that a solution could be reached in a few seconds, at the end of which time the thinker is required to describe what had passed through his mind in the process of solution. It is essential to the method that the same general sort of problem be set many times in succession, and that the preliminary consciousness intervening between the signal "Ready!" and the propounding of the particular problem should be described, as well as the consciousness transpiring between the propounding of the problem and the attainment of the solution. Whatever else may be said of the method, it has at least produced a large mass of data regarding matters which had previously been the subject of only casual observation. The method has been sharply criticized by no less an authority than Wundt, on the ground that it does not fulfil the essential requirement of experimental observation. In a proper experiment, as Wundt says, the observer knows beforehand exactly where his attention must be directed; the field of observation is narrowed, and the observation is consequently more minute and accurate than in ordinary circumstances. In this new work, however, the observer, who is also the person experimented on, does not know beforehand exactly what he has to observe, and, besides, must devote his attention first of all to the solution of his problem, and only secondarily to the observations which are desired. With this line of criticism, which is evidently the old, familiar objection to introspection in general, our author seems not to agree. He regards the work so far done as a promising beginning, except that too much has been attempted at once, and that some of the experimenters have been contented with observations on what the thought was about, instead of insisting on a description of the thought as a mere conscious fact.

As to the results of this work, one at least has been gained, and is freely admitted by Professor Titchener. It will be remembered that the problems set in any one series were of one general nature, which was understood beforehand. The thinker becomes adjusted to this general task, as is shown by the fact that the propounding of the particular problem is usually followed promptly by a course of thought leading to or towards the solution, to the exclusion of numerous other associations which might otherwise be recalled by the words, etc., used in putting the problem. The preliminary adjustment limits or directs the play of association. Yet, usually, no consciousness of the nature of the task can be detected in the interval between the setting of the particular problem and the reaching of the solution. What consciousness there is of the nature of the task comes in the preliminary period, after the ready-signal; and, even here, as the series of similar problems progresses and the task becomes familiar, the consciousness of it tends to be reduced, and finally to disappear, though the adjustment to the task is all the time improving. This result is valuable both as illustrating the relation of consciousness to mental function, and as indicating a dynamic factor in thought. In both respects, the result is not entirely new, having been foreshadowed, in another field, by conclusions of some of the early students of reaction times (Exner, Cattell, Lange); but it has now received a much wider extension.

Another curious result is the frequent occurrence, in these experiments, of states of mind in which one is clearly aware of the task in hand, or of the solution, or of some other fact, but is unable to detect any image or sensation, or anything which can be described except as the "thought of" so and so, or the "knowledge that" so and so. Some of the experimenters, particularly Bühler and the present reviewer, have been content to regard this description adequate, and to conclude that such "thoughts" were elements of

consciousness, irreducible to complexes of sensations and images, and of a kind hitherto unrecognized by most psychologists. Our author disbelieves altogether in the elementary character of such thoughts; he emphasizes the crudeness of the methods employed, and believes that more refined study will probably reveal vestiges of images and sensations of bodily attitudes, as components of what has been called imageless or non-sensorial thought.

In addition to its main purpose, the book is valuable as throwing a clearer light than any of his previous writings on the author's guiding principles in psychologizing.

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SOME SUGGESTIONS FOR THE STUDY OF COMETS[1]

Comets are, probably, the most mysterious of all celestial objects. Whence they come; whither they go, when they leave forever; where they gather fresh material, if they do, and how; their mechanical structure; the forces that commonly bind them together; the other forces that sometimes tear them apart; the origin of the curious knots, twists and streaks in their tails; and why it is that they are self-luminous, are among the things concerning comets we should like to know, but which, at present, no physicist and no astronomer can tell us.

It is but natural therefore that the return and near approach of Halley's comet should arouse unusual interest and activity in the study of these strange objects, for it is bringing us a rare chance, especially if, as seems likely, the earth should pass through its tail, of learning much that we would like to know in regard to comets and their accompanying phenomena. But to make such a study most efficient it is necessary to consider what phenomena may possibly be expected, and how they can be observed.

These form two distinct groups, namely: (1) celestial, astrophysical in the main; (2) terrestrial, chiefly meteorological. Among the former are:

(*a*) *Gross Appearances.*—This includes all distinctive markings, such as bright patches; streaks, both straight and twisted; number, direction and shape of tails; time and manner of beginning and ending of tails; and any other such phenomenon as may present itself to the observer. A photographic record, as nearly as practicable continuous, should be taken of these phenomena for future study, but it would be well to supplement the photographs by numerous eye observations.

Any one expecting to do work of this nature, and there are many observatories adequately equipped for it, would do well to consult Professor E. E. Barnard, of the Yerkes Observatory, either directly or through his papers on comets.

(*b*) *Spectrum.*—Visual and photographic analysis of the light should be applied to the comet in detail—to the jets and envelopes in and about the head, to the streaks in the tail and to all portions bright enough to yield results.

Such a program, while of decided value, can not profitably be undertaken except by those observatories especially well equipped for this sort of work.

(*c*) *Polarization.*—It is known that the light of comets is polarized to some extent, from which it is inferred that a part of their luminosity is due to reflected sunlight, but this phenomenon needs further examination, and, in particular, separation from sky polarization. It would be well to compare the polarization of that part of the comet where a right angle exists between the directions from it to the sun and the earth, respectively, with the polarization of other portions. If the particles of the comet are small in size, compared with the cube of an average wave-length of light, then, as Rayleigh has shown, there will be

[1] This paper was prepared at the request of the comet committee of the Astronomical and Astrophysical Society of America for inclusion in its circular respecting observations of Halley's comet. Through causes for which its author is in no way responsible it did not reach its destination in time to be so used and the committee now seeks to give it publicity through the pages of Science and such other journals as may choose to reproduce it.

marked polarization that is a maximum in a direction at right angles to the incident radiation. It is true that we have in the turning of the tail always away from the sun strong evidence (since this is due, we believe, to light-pressure) of the minute size of the luminous particles; but, nevertheless, such evidence as the phenomena of polarization can give on this point is worth having.

It would also be desirable to determine the relative amount of reflected to intrinsic light, though the method of accurately doing this is not obvious.

Polarization work can be done with any *refracting* telescope of large light-gathering power. A reflecting telescope could not be used for this purpose because of the polarization effects that it itself would introduce.

(*d*) *Light-fluctuation.*—It is well known that the light of comets often varies irregularly and without obvious cause. These variations should be studied in connection with the formation of jets and envelopes, and especially observed to see where the changes in brilliancy have their origin and how rapidly they spread to other parts.

The position and size of sun spots, and other solar phenomena, should also be observed and studied in connection with the light changes. Evidently the luminescence of comets is, in some way, largely dependent upon the sun, and it has been claimed that it is greatest during periods of sun-spot maxima. If so, then it may change with the size and orientation of the spots. At any rate, this is a phenomenon that can easily and, perhaps, profitably be studied with the aid of even a very modest equipment.

All the above phenomena can be observed at any time the comet is brightly visible, but there are a number of other phenomena which possibly may appear or be modified during the passage of the earth through its tail, if, fortunately, such an occurrence should happen, and which, therefore, ought to be carefully watched at that time. These form the second or terrestrial group, above mentioned, some of which are:

1. *Electrical Potential.*—In reality it is the difference between the electrical potentials of two points a given vertical distance apart in the atmosphere that is here referred to. This would be modified by the bringing of an electrical charge from some extraneous source to the atmosphere, and, conceivably, might therefore help to give some idea of the electrical condition of that part of a comet's tail through which we happened to pass. But, as the electrical state of the atmosphere changes so greatly from place to place and from day to day, it does not seem that observations of this nature can afford much definite information.

2. *Atmospheric Conductivity.*—This comes, essentially, to the same thing as the ionization of the atmosphere, and would be modified by the entrance into the air of charged particles or other ionizing agents.

Like the electric potential of the air this too is subject, ordinarily, to such changes that, seemingly, no trustworthy inference in regard to the electrical condition of a comet's tail, should we pass through one, could be drawn from such observations.

However, if any one, not entirely familiar with them, wishes to take up either or both of these lines of work he will find Gockel, "Die Luftelektrizität," a good guide.

3. *Damping of Electrical Waves.*—It is well known that the distance a wireless message can be received changes irregularly, owing, presumably, to the intensity and distribution of the ionization of the atmosphere. The ease or difficulty of transmitting wireless messages, especially over the ocean, say from San Francisco to Honolulu, might, therefore, give some hint about the electrical state and the ionizing action of the material of a comet's tail through which the earth at that time might chance to be passing. Probably the hint would not be a very distinct one, but observations of this phenomenon seem to the author much more promising of results than do those of either the potential or the conductivity of the atmosphere.

4. *Earth Currents.*—A marked change in the electrical condition of the atmosphere is likely to lead to earth currents of greater or less magnitude. It might therefore be well to

request telegraph and telephone companies to report any such disturbances as may occur during our passage through the comet, should this happen. However, such currents should be considered only in connection with other phenomena, since alone they can have but little meaning.

5. *Diurnal Variation of the Earth's Magnetism.*—It has been known for a long time that there is regularly both a diurnal and a semidiurnal variation in all the elements of terrestrial magnetism; and it has been shown by Schuster[2] that the origin of these daily disturbances is outside the surface of the earth. The origin of this variation is, probably, the Foucault currents caused by the sweep of the ionized, and therefore conducting, air across the lines of magnetic force. The more ionized, or the better conducting the air, other things being equal, the greater these currents and, if this theory is correct, the greater the resulting diurnal variation in the records obtained at magnetic observatories.

If then the particles of a comet's tail are highly electrified, or should in any way produce, on our coming into them, an ionizing action on the atmosphere, there must result corresponding changes in the diurnal variations. The action of the cometary particles, presumably, would be on the outer layers of the atmosphere where any change in the conductivity is most effective. Also since, in general, the winds increase with latitude and the lines of magnetic force become more concentrated and more nearly vertical, therefore any change in the diurnal variation, especially of the declination, that may be due to the action of a comet's tail probably would be most marked in the higher latitudes.

It seems, therefore, that it would be especially well to study and compare the diurnal variations obtained at the many excellent magnetic observatories just before, during and just after the coming passage of the earth through the tail of Halley's comet—assuming, of course, this event to take place.

6. *Auroral Displays.*—Auroras serve as rather delicate indicators of the electrical state of the outer atmosphere, and therefore should be carefully watched for and minutely noted during a continuous period of several days equally overlapping the supposed epoch of our intersection with the material of the comet.

7. *Line and Band Absorption.*—The atmospheric absorption lines and bands furnish about the best means we have for detecting changes in the composition of the atmosphere, especially of the outer portions. Therefore it may be desirable to compare the atmospheric lines and bands during the passage of the earth across the comet's tail with the lines and bands obtained at other times.

If the electrification of the outer air is materially changed during this passage there may result a corresponding temporary change in the amount of ozone in that region, that perhaps could best be detected through the great ozone absorption band[3] at wave-lengths 9 μ to 10 μ.

8. *Atmospheric Transmission.*—In reducing the data obtained with integrating pyrheliometers it is customary to use, with certain corrections, the simple Bouguer equation,

$$I = I_0 a^m,$$

in which I is the observed solar intensity through the air mass m, I_0 the intensity outside the atmosphere, and a the coefficient of transmission. This latter varies from day to day, but, assuming it to remain constant for a few hours, can be determined by observations taken with different values of m, or, as Kimball[4] has shown, by a single observation of the intensity, together with a simultaneous measurement of sky polarization.

Since a is such a variable quantity its determination while, perhaps, of some value in this connection, can not be regarded as very promising of definite information concerning the material of a comet through which we might be passing.

9. *Meteoric Trails.*—Since the particles com-

[2] *Phil. Trans.*, A, Vol. 180, p. 467, 1889; Vol. 208, pp. 163–204, 1908.

[3] Angström, *Arkiv för Matematik, Astronomie och Fysik*, 1, 395, 1904.

[4] *Mount Weather Bulletin*, 2, pp. 55–65, 1909.

posing the tail of a comet presumably are excessively minute, any meteoric trails they may produce on coming in contact with the atmosphere must be small. However, it would be well, at the proper time, to watch for them with a telescope pointed nearly vertically and focused for a distance of from 100 to 150 miles. Presumably only faint scintillations, probably entirely too faint to be seen, need be expected, but only by such observations can we know definitely just what does or does not take place.

10. *Bishop's Ring.*—After the explosion of Krakatoa, and also after that of Mount Pelé, a faint reddish brown ring of the coronal type was seen about the sun. Its inner radius was about 12°, and its outer approximately 22°. It was due, almost certainly, in both cases, to finely divided matter thrown up to great altitudes and from there spread widely over the earth. The mean radius of these particles, assuming them spherical in shape, has been calculated to be about equal to the largest visible wave-length. They were therefore excessively minute, and it is possible that after passing through the tail of a comet something of this kind may be seen; at any rate, careful observation should be made for it, after such an event, by those of exceptionally sensitive eyes. Such observations are best made with the sun hidden behind an opaque object.

11. *Color of the Sun.*—The color of the sun, as is well known, depends upon the size and number of solid or liquid particles through which it is seen, and therefore may, possibly, be temporarily modified on our passing through a comet's tail.

12. *Atmospheric Polarization.*—This phenomenon depends mainly upon the scattering of sunlight by any minute particles in the atmosphere. The percentage of the polarized to the total sky light at any part of the sky, say where the polarization is a maximum, or 90° from the sun on the vertical circle passing through it, is a function of the dust content of the air. This percentage therefore should be carefully noted during our supposed coming passage through the tail of Halley's comet, as should also the positions of the so-called neutral points of Arago, Babinet and Brewster—the first especially, as it is the easiest observed and most accurately determined.

It might also be advisable to observe the polarization percentage of different colors, by the aid of suitable screens, since this depends upon the size of the particles that scatter the light.

13. *Twilight Phenomena.*—Twilight colors, and the gamut of changes through which they run, clearly are dependent upon the dust content of the atmosphere, as was strikingly evident after the eruption of Krakatoa, and therefore might, possibly, afford some information in regard to the tail of any comet through which the earth may pass.

14. *Luminous Clouds.*—After the eruption of Krakatoa there was seen for many years, but only in latitudes of 45° or more, faintly luminous clouds of, seemingly, great altitudes.

It is not at all certain that these so-called clouds were due in the least to the volcanic eruption; but still they should be closely looked for at the time of and after our passage through a comet's tail, since they might be modified by the material thus picked up.

15. *Number of Dust Particles in the Air.*—The number of dust particles, especially in the outer portions of the atmosphere, may be greatly increased by the passage of the earth through the tail of a comet. Therefore it would be well to count the particles of dust per cubic centimeter say of air on the tops of high mountains, and in samples obtained by sounding balloons, before and just after the time of our entrance into the tail of Halley's comet.

16. *Zodiacal Light.*—While our knowledge of the zodiacal light, of the nature and location of the material to which it is due, and how this material is rendered luminous, is practically nil, it seems quite possible that its real or apparent brilliancy may be greater during our passage through even so rare a substance as the tail of a comet. Therefore the details of this phenomenon too should be recorded, at the proper time, by those so situated as to observe it to good advantage.

17. *Gegenschein.*—But little is known of the

cause or location, except in direction, of the *gegenschein,* but it seems not improbable that it may be more distinctly visible during the passage of the earth through the luminous particles of a comet's tail, and therefore it should be studied, at the proper time, with the greatest care by those in the habit of observing it.

18. *The Auroral Line.*—Arrhenius[5] says:

> Whichever way we turn the spectroscope on a very clear night, especially in the tropics, we observe this peculiar green line. (The so-called auroral line.) It was formerly considered to be characteristic of the zodiacal light, but on a closer examination it has been traced all over the sky, even where the zodiacal light could not be observed.

Evidently the source of this line is not definitely known, but, conceivably, it may be rendered more brilliant by the passage of the earth through the tail of a comet, and therefore it would be well for some favorably situated observer carefully to measure its brilliancy on several consecutive nights, so selected as symmetrically to overlap the calculated date of our supposed passage through the tail of Halley's comet.

The most promising, in this connection, of the above phenomena are, in the author's opinion, those designated as *a, b, c, d,* 5, 6, 9, 10, 13, 16 and 17.

The above is not claimed as a complete list of the phenomena that may be associated with a comet, but it is hoped that they, together with others that they may suggest, will soon give us a better understanding of comets in general and of Halley's in particular.

W. J. Humphreys
Mount Weather Observatory,
Bluemont, Va.

[5] "Worlds in the Making," p. 116.

SPECIAL ARTICLES

SOME LONG-PERIOD DEVIATIONS OF THE HORIZONTAL PENDULUMS AT THE HARVARD SEISMOGRAPHIC STATION

The studies of Omori, Milne, Denison and many others, on the movements of horizontal pendulums due to other than seismic or microseismic causes, suggested a similar study of the movements shown by the pair of Bosch-Omori instruments at the Harvard station. These pendulums, which stand at right angles to each other on the meridian and parallel of the station, record through small tracers on sheets of smoked paper carried by drums that complete a revolution once in an hour. The drums travel laterally, causing each hour's record to appear as a single line spaced about an eighth of an inch from its neighbor on either hand. A complete day's record, undisturbed by seismic or other movements, appears as a series of twenty-four parallel lines. Any long-period deviations of the pendulums, therefore, are shown by a crowding of these lines toward one side of the sheet or the other.

The study was made to determine whether or not solar or cyclonic and anticyclonic conditions affect the pendulums, as has been suggested. Lack of time prohibited an investigation of tidal and other effects, except so far as to prove them entirely subordinate to the main controls. The records were examined for the months of April, May, October, November and December, 1908. The pendulum standing on the meridian of the station (the east-west component, so-called) is most sensitive, in the matter of long, non-periodic movements, to forces applied due east or west of the station. The same is true of the north-south component in reference to forces applied on the north or south.

Two types of deflection are shown by each component:

The E.-W. Component: Type 1.—A diurnal deflection. This is indicated by a more or less strong tendency of the pendulum to move east during the forenoon and west later in the day. It begins about sunrise, the more or less steady easterly travel dying out about noon and later becoming a westerly travel which often lasts well into the night. This type of deflection never persists from one twenty-four hours into the next; it occurs only on days when the sun shines, and is best shown on the least cloudy days. When the diurnal quality of the thermograph curve is most marked, the pendulum

records the strongest diurnal deflection. Some kind of solar control seems necessary to explain these movements. The method of its action has not been made out.

Type 2.—Correlation of the movements of the pendulum with the movements of areas of low and high barometric pressure across the United States and southern Canada, shows an intimate relation between them. An easterly deflection of the E.-W. component begins when an area of low pressure appears in some westerly or southwesterly direction from the station. The cyclone may be even 1,500 or more miles away when the deflection begins. The time of beginning seems to depend partly on the movements of a high-pressure center to the east, though such a relation can not be definitely worked out until more complete knowledge of conditions over the Atlantic Ocean is available. There appears to be at least a general relation between the amount of pressure at the center of the cyclone, the area covered by it, the rapidity of its movement, and the time of beginning and the rapidity of easterly travel of the pendulum. As the depression moves east or northeast, the pendulum also moves toward the east until the cyclone is nearly over the station, and as the depression passes off the coast, the pendulum begins to travel toward the west. Inspection of the current weather map shows an area of high pressure, or one of less intense low pressure, than that which caused the deflection, to be approaching easterly in the western quadrant. As the anticyclone comes nearer, the westerly travel usually increases in rapidity. When the center is approximately over the station, the direction of travel is reversed and the cycle repeated. These deflections occupy any length of time, dependent wholly on the time taken for the passage of the cyclone or anticyclone. They often begin many hours before the barometer indicates the approach of minima or maxima. They do not go on uninterruptedly; there are countless minor variations the causes of which it is as yet impossible to determine. The diurnal deflection is superimposed on these longer, non-periodic deflections.

The N.-S. Component: Type 1.—A diurnal deflection. This is indicated by a more or less strong tendency of the pendulum to move south during the forenoon, and north later in the day. It is much less clearly shown than the diurnal of the E.-W. component, and is apparently dependent on the same causes.

Type 2.—Deflections cyclonically or anticyclonically controlled. These include all movements due to the approach of high or low pressure areas from some westerly direction. They are somewhat less frequent, and usually much less marked, and their period of maximum activity is nearly always much shorter than is the case with the deflections of the E.-W. component. This is apparently due to the parallelism of the N.-S. component to the mean cyclonic and anticyclonic tracks. The approach of a *high* from the northwest and its passage north of the station, or the approach of a *low* from the south or southwest and its passage south, is accompanied by a northward deflection of the pendulum. This reaches its maximum when the pressure gradient runs due north, and becomes a southerly deflection when pressure conditions are reversed. Often interrupting these deflections are temporary movements for a few hours in a contrary direction, followed by the renewal of the long-period travel. These variations do not affect the general tendency, and their causes have not been made out. The diurnal deflection is superimposed on these longer, non-periodic deflections.

The summary presented in the table below shows for each component the per cents of cases (on the basis of numbers of days out of the total) in which the particular deflection occurred. A more desirable basis would be units by cyclones and anticyclones; but the variability of the time taken for the passage of these areas by the station, their complex distributions, and the impossibility of evaluating the share that each has in producing a given deflection, makes it impracticable to determine the limits of any one unit. The per cents. of movements from *lows* toward *highs* are considerably smaller than they would be if computed on the latter basis, for they take

account of temporary reversals in deflection which are lost sight of in the general deflections lasting for an indefinite period.

	E.-W. Component.		N.-S. Component.	
	Deflection from *Lows* toward *Highs*	Deflection from *Highs* toward *Lows*	Deflection from *Lows* toward *Highs*	Deflection from *Highs* toward *Lows*
April.	70.0 %	30.0 %	55.0 %	45.0 %
May.....	95.2	4.8	69.5	30.5
October....	94.7	5.3	62.5	37.5
November.	83.3	16.7	77.7	22.3
December.	100 0	0.0	85.7	14.3
Mean.....	88.5	11.5	69.0	31.0

It will be noticed that the pendulums show greater response to pressure conditions during the fall and winter months than during the spring months. This is to be expected, inasmuch as barometric maxima and minima are best developed during fall and winter. The records for the summer months were not examined critically on this account. The study thus far has been entirely qualitative; quantitative work has been found unsatisfactory owing to the lack of a recording device which shall obviate the running together of the hourly lines at the very frequent times of extreme deflection.

The causes of the movements here described are obscure. Many suggestions regarding the causes of similar movements elsewhere have been made, but no one of them is corroborated as yet by sufficiently wide-spread observation, to warrant its being fully accepted. It would seem that causes which may be operative over long distances must be assumed, for the pendulums at Cambridge show distinct movements in sympathy with barometric maxima and minima when these are still very far distant from the station.

The possibility of using horizontal pendulums in forecasting on windward coasts has been suggested by Mr. F. Napier Denison, of the Meteorological Office at Victoria, B. C. If, as in the case of the Harvard station, horizontal pendulums in general announce the approach of various pressure conditions in advance of the barometer, the use of simple instruments of this type in situations where maps of weather conditions to windward are not available, might lead, especially in the latitudes of the prevailing westerly winds and cyclonic storms, to valuable results.

B. M. Varney
Harvard University

A SIMPLE AND EFFICIENT LECTURE GALVANOMETER ARRANGEMENT

In view of the extensive use to which the lecture galvanometer is nowadays put in physical and other laboratories, I have been induced to describe a particularly simple arrangement which has been thoroughly tested and whose performance leaves little to be desired.

In this arrangement a firm tripod, supported by a convenient shelf on one wall of the lecture room, carries a 90° arc lamp clamped by a right-angle piece to its vertical rod. The lamp is mounted with the positive carbon vertical, and its luminous tip, the source of light, uppermost. On a wall bracket a converging lens with its axis vertical is mounted about a meter above the arc. The galvanometer, a D'Arsonval instrument with plane mirror, is mounted on a wall shelf with its mirror, *A*, about 0.4 meter above the lens and about 0.1 meter nearer the wall. A second and larger plane mirror, *B*, is mounted with universal adjustments at the edge of the galvanometer shelf. It is fixed vertically above the lens in a horizontal plane a little below *A*. A scale with 2-inch divisions is mounted horizontally near the top of the wall opposite the galvanometer about 9.5 meters away. The galvanometer terminals are permanently connected with binding posts on the lecture table.

When the optical adjustments have been made, light from the tip of the positive carbon, converged by the lens, falls upon the mirror *B* and then upon the mirror *A*, which reflects it to the scale. At the center of the scale a round and brilliant image of the luminous carbon tip is formed. Focal adjustments can be made by moving the lens vertically on its bracket, or the lamp vertically on its rod; and the position of the image on

the scale can be adjusted with ease and precision by moving the tripod on its shelf. With the lens used in my apparatus, which is 8 cm. in diameter, the range of the latter adjustment is very great.

The galvanometer mirror used here is $\frac{5}{8}$ inch in diameter. The lamp can be operated with either direct or alternating current, and the image is so bright that it has never been necessary to darken the room. The inexpensive lamp of the type used here is provided with a metallic hood, and with a pin hole and mica screen for adjusting the arc, which is controlled by hand. As used in this arrangement the edge of the hood is horizontal. While the round image of the carbon tip is sharp enough for all ordinary purposes, readings being taken to tenths of scale divisions, yet if it is desired to make one edge of the image straight and perfectly steady, this can be done simply by laying a bar of metal on the hood and moving it partly over the carbon until the adjustment is correct. By using a larger mirror on the galvanometer a more brilliant image could of course be obtained.

The arrangement described above has been in use here for over a year. During the preceding three years an automatic lamp with vertical carbons and an extra mirror were used instead of the hand regulated 90° lamp. The second arrangement has proved to be more satisfactory than the first. An automatic 90° lamp would of course be still more satisfactory.

S. J. BARNETT
THE TULANE UNIVERSITY OF LOUISIANA

THE AMPHIBIA OF THE MAZON CREEK SHALES

THERE have been but two species of Amphibia recognized from the shales which are exposed along Mazon Creek, Illinois. These two species are the remarkable reptile-like microsaurian *Amphibamus grandiceps* described in 1865 by Professor Cope and the salamander-like branchiosaurian described the past year by the writer under the name *Micrerpeton caudatum*. It is thus with considerable interest that the writer is able to announce the discovery of seven additional species distributed in six additional genera. This new and considerable addition to the knowledge of the Mazon Creek fauna is made possible through the courtesy of Drs. Schuchert and Eaton, of Yale University, who very kindly placed at the writer's disposal the entire collection of Mazon Creek Amphibia belonging to that institution.

The material is represented by ten specimens, including the most perfect example of *Amphibamus grandiceps* so far seen. This specimen makes possible the verification of the author's restoration of that form and the addition of the ischia. The other specimens are undescribed and represent a diverse fauna. An additional species of the family Amphibamidæ is represented by a well-preserved anterior half of a skeleton. Three additional branchiosaurian species are preserved. One of these species, represented by two specimens, is most remarkable for the preservation of the entire alimentary canal and a portion of the oviducts in both specimens. This on comparison with living Amphibia proves to show close resemblances to the alimentary canal of an immature branchiate individual of *Diemyctylus torosus* Eschscholtz from a freshwater pond on Orcas Island in Puget Sound. The other two species are remarkably like *Branchiosaurus* of Saxony, but differ in having an extremely elongate tail.

Perhaps the most interesting discovery in this new material is that of a primitive embolomerous amphibian of the order Temnospondylia. It is related to *Cricotus* and may be placed in the family Cricotidæ. It differs from *Cricotus,* however, in the form of the centrum and the relatively greater length of the component elements. The notochordal canal is widely open. A sixth species is founded on a fore limb which shows relationships to the family Molgophidæ, which has, so far, been known only from the Coal Measures of Linton, Ohio.

Our knowledge of the amphibian fauna of the Pennsylvanian up to the present time would indicate that the forms had already developed into local groups which had few connecting types. We may regard the new

member of the Molgophidæ as one of these connecting types. This localized specialization means that we must look into the Mississippian and the Devonian for the earliest of the Amphibia in North America, as the foot prints which have been discovered in these deposits would indicate.

The discovery of the new temnospondylous form with other facts of the distribution of the Temnospondylia indicates that the order originated in North America. At least the earliest known forms occur in this continent.

The amphibian fauna of Mazon Creek at the present time may be regarded as represented by nine species which are members of four orders and five families. The orders are: Branchiosauria, Microsauria and Temnospondylia. An additional fact of interest is the discovery of osseous branchial arches in an imperfectly preserved specimen; the second species from the Pennsylvanian in which these structures have been seen. This means the presence of a fourth order of Amphibia in the Mazon Creek shales.

Roy L. Moodie

The University of Kansas,
January 14, 1910

A FIXING FLUID FOR PLANT TISSUES

My experience with Bouin's fluid as a fixing material for certain plant tissues for cytological work has been so satisfactory that I take this opportunity of recommending it to plant cytologists as one which combines a number of admirable features. It has, of course, been used for a number of years in connection with animal tissues, and especially for studies of spermatogenesis, in which it gives notably clear preparations. I first tried it, along with a number of other solutions, for fixing anthers of *Œnothera,* in 1908. The formula used was as follows:

	Parts
Picric acid, saturated aqueous solution ..	75
Glacial acetic acid	5
Formaline	20

Of course, various modifications of this may be found advantageous for different plant forms.

The time of fixation must be short, otherwise maceration results. It should probably not exceed four to six hours. The time of washing must also be comparatively brief, as long washing causes deterioration and fragmentation of the material. *Œnothera* anthers, after a few hours' immersion in this fluid, frequently acquire a slight pinkish tint, which remains indefinitely after the material has been dehydrated and placed in 70 per cent. alcohol.

This solution seems to be a favorite one for studies on animal spermatogenesis, and I see no reason why it should not become popular also for various purposes in plant cytology. Its obvious advantages are (1) that, unlike osmic solutions, it leaves the tissues clear and transparent, (2) its penetration seems to be very rapid, giving an even and almost perfect fixation of the material, (3) it leaves the cytoplasm and nuclei perfectly colorless, giving particularly clear and brilliant results in staining chromatin and spindles when followed by Heidenhain's iron-hæmatoxylin stain.

R. R. Gates

Missouri Botanical Garden

THE AMERICAN SOCIETY OF NATURALISTS

The American Society of Naturalists met at the Harvard Medical School, Boston, Mass., on Wednesday, December 29, 1909. There were both morning and afternoon sessions. The program consisted of original papers and demonstrations of studies on evolution, and the meeting proved to be one of the most successful in the history of the society. The variety and importance of the papers read are well shown by the following list of titles:

PAPERS

U. Dahlgren: "Origin of the Electric Tissues in Teleost Fishes" (lantern).

D. T. MacDougal: "Origination of Parasitism in Higher Plants."

F. Boas: "The Influence of Heredity and of the Environment on Man."

E. Brainard: "The Evolution of New Forms in *Viola* through Hybridism."

R. R. Gates: "The Material Basis of Mendelian Phenomena" (lantern).

A. M. Lutz: "The Relation of Chromosome

Number to Vegetative Characters in the Œnothera" (lantern).

G. H. Shull: "The Inheritance of Sex in *Lychnis*."

F. E. Lutz: "Experiments concerning the Reversion of Domesticated Races to the Wild Type."

W. J. Spillman: "Mendelian Phenomena Independent of de Vriesian Hypotheses."

C. B. Davenport: "Some Consequences of Imperfect Dominance."

J. Reighard: "The Biological Meaning of Conspicuousness in Animals" (lantern).

T. H. Montgomery: "Secondary Sexual Characters in Spiders."

C. W. Beebe: "Racket Formation in the Tail Feathers of the Mot-Mot."

E. M. East: "A Mendelian Interpretation of Variation that is Apparently Continuous."

W. L. Tower: "Causes and Consequences of Variability in Alternative (Mendelian) Inheritance in Experiment and in Evolution" (lantern).

W. E. Castle: "On the Nature of Mendelian Factors."

A. F. Shull: "The Artificial Production of the Parthenogenetic and Sexual Phases in the Life Cycle of *Hydatina senta*" (read by Professor T. H. Morgan).

H. S. Jennings: "Experimental Evidence on the Effectiveness of Selection."

There were interesting discussions of some of the papers; but the program this year, unfortunately, proved to be too crowded to permit of the proper time allowance for this very desirable feature.

DEMONSTRATIONS

A new departure was the demonstration of specimens, etc. This list also surely indicates that the naturalists have selected a most promising field of interest to all biologists.

U. Dahlgren: Gross and microscopic preparations of electric tissues; also lantern slides.

D. T. MacDougal: Parasitism in plants.

R. R. Gates: Lantern slides.

A. M. Lutz: Paintings, lantern slides and microscopic preparations of Œnothera.

F. E. Lutz: Specimens.

W. J. Spillman: Specimens.

C. B. Davenport: Illustrations of inheritance of plumage color.

J. Reighard: Colored photographs and transparencies.

C. W. Beebe: Bird skins.

E. M. East: Specimens and lantern slides.

W. L. Tower: General demonstration arranged to illustrate phases of investigation now in progress. (1) photographs; (2) specimens showing results.

W. E. Castle: Specimens.

H. S. Jennings: Diverse genotypes in *Paramœcium*.

COOPERATION

The Botanical Society of America left most of Wednesday morning free to the Naturalists, and the American Society of Zoologists adjourned early in the day. Thus good audiences were possible. It seems probable that interest in the society will continue and grow, if the program is, in future, kept closely in touch with modern work of such general importance to all biologists. This was, after all, the essential principle of the society in its early years.

PUBLICATION OF PAPERS

The papers presented before the society will be published in *The American Naturalist*, in a series, as supplied by the authors.

The president's address, on "Chance or Purpose in the Evolution of Adaptations," was delivered at the dinner in the Hotel Somerset, on the evening of the same day. This address is published in the present number of SCIENCE.

NEW MEMBERS

The following new members were elected: F. N. Balch, Boston, Mass.; R. S. Breed, Allegheny College; R. Chambers, University of Toronto; H. Colton, University of Pennsylvania; W. W. Ford, Johns Hopkins Medical School; A. J. Goldfarb, New York; H. G. Kribs, University of Pennsylvania; A. Petrunkevitch, American Museum of Natural History; Q. J. Simpson, Palmer, Ill.; F. M. Surface, University of Maine; C. B. Thompson, Wellesley College.

The officers elected for the year 1910 are:

President—Dr. D. T. MacDougal, Carnegie Institution.

Vice-President and chairman of the Eastern Section—Dr. H. S. Jennings, Johns Hopkins University.

Treasurer—Dr. E. M. East, Bussey Institution, Boston, Mass.

Secretary—Dr. C. R. Stockard, Cornell University Medical School.

Members of Executive Council—Dr. Raymond Pearl, University of Maine, and Dr. F. Boas, Columbia University.

H. McE. KNOWER,
Secretary for 1909

THE AMERICAN SOCIETY FOR PHARMACOLOGY AND EXPERIMENTAL THERAPEUTICS

THIS society, which was organized at Baltimore, December, 1908, held its first annual meeting in Boston during convocation week. The object of the society is to promote pharmacology and experimental therapeutics and to "facilitate personal intercourse between investigators who are actively engaged in research in these fields." The membership is now fifty-two.

At the business meeting on December 29 a constitution was adopted and the following officers elected:

President—J. J. Abel.

Secretary—Reid Hunt.

Treasurer—A. S. Loevenhart.

Additional Members of the Council—A. C. Crawford and G. B. Wallace.

Membership Committee—C. W. Edmunds, S. J. Meltzer and Torald Sollmann.

On December 30 a scientific session was held at which the following demonstrations and papers were presented and discussed:

DEMONSTRATIONS

D. R. Joseph and S. J. Meltzer: The mutual antagonism between magnesium and barium.

J. Auer (with P. Lewis): Demonstration of anaphylactic immobilization of the lungs in guinea-pigs.

W. H. Schultz: A simple respiration apparatus.

S. J. Meltzer: A demonstration of the method of respiration by continuous intratracheal insufflation.

PAPERS

Central Vasomotor Effects: T. SOLLMANN (with J. D. PILCHER).

An organ is left in connection with the vasomotor center, but separated from the circulation, and perfused artificially. Cardiac effects, and direct actions on the vessels, are thus excluded, thereby permitting the study of the activity of the vasomotor center. The response of this center to physiological and pharmacological conditions is under investigation; a number of the results were reported.

Studies upon the Action of Certain Salts on the Isolated Intestines: M. V. TYRODE.

Strips of rabbit's small and large intestines kept alive in the author's nutritive medium and tested by different methods showed an increased motor activity when magnesium sulphate, sodium sulphate and sodium phosphate were applied internally but decreased activity when these salts were applied externally, particularly well marked after magnesium sulphate.

On the Behavior of Certain Arsenical (and other) Compounds in the Treatment of Experimental Nagana: J. J. ABEL (with L. G. ROWNTREE and E. A. SLEGLE).

The authors have met with success in the treatment of experimental nagana in using certain arsenical and antimony compounds, whose method of preparation together with results obtained will be described in detail in the near future.

The Effect of Certain Drugs upon the Toxicity of Acetphenetidin and Paramidophenol: W. HALE.

A control series of mice were fed plain cakes or upon cakes to which a single drug had been added, and the time until their death was noted. In a second series cakes were fed which contained a mixture of two of the above drugs. In this way it was shown that the toxicity of acetphenetidin (phenacetin) and para-amidophenol was increased in mixtures with small amounts of caffein, sodium bicarbonate and codeine.

On the Pharmacological Action and Antiseptic Value of Certain Benzoic Acid Derivatives: A. S. LOEVENHART (with A. ARKIN).

The following products were studied:

(1) Sodium ortho-iodbenzoate, $C_6H_4\langle^{I}_{COONa}$

(2) Sodium ortho-iodosobenzoate, $C_6H_4\langle^{I{=}O}_{COONa}$

(3) Sodium ortho-iodoxybenzoate, $C_6H_4\langle^{I(=O)_2}_{COONa}$

The first has very little antiseptic action, while the second and third are antiseptics of considerable strength for the organisms studied. Evidence was presented to show that the germicidal properties of these substances is dependent upon the active oxygen combined with the iodine. The presence of protein did not diminish the antiseptic action of these substances. Work is under way to establish their therapeutic value.

The Effects of Urea and Hypertonic Solutions on the Circulation: J. A. E. EYSTER. (Read by title.)

Urea causes an increase in the size of contraction of the frog's and terrapin's heart. Hypertonic solutions of sodium chloride and glucose exert a similar effect, but the effect with urea

occurs also in isotonic solution. Isotonic solutions of urea cause a slight constriction of the blood vessels of the frog, hypertonic solutions of urea and sodium chloride a dilation. Hypertonic solutions of urea, sodium chloride and glucose injected intravenously in cats and rabbits cause an increase in cardiac output and a vasodilatation of the intestinal and renal vessels.

The Biological and Chemical Assay of Ergot: H. C. WOOD, JR.

The method used for determining the activity of ergot physiologically was based on the rise of blood pressure, the average rise for ten minutes after the injection being taken as the physiological figures. Comparative tests having shown that the amount of benzol soluble matter in the fluid-extract of ergot bears a close relation to the physiological activity of the specimen, a method of chemical assay based on this fact was suggested. The body obtained by extracting the fluid-extract with benzole yields a nitrogenous body on prolonged shaking with dilute acids, which is highly active.

Inhibition of the Pancreas: C. W. EDMUNDS.

The pancreatic secretion produced by secretin is inhibited by the vaso-constricting action of adrenalin, nicotine, pituitary extract and strychnine. When these drugs do not cause vaso-constriction they do not inhibit the pancreas. After the injection of adrenalin the pancreas may not regain the normal volume for five minutes and with pituitary extract it may be eight minutes, which facts explain why the inhibition persists after the blood-pressure has returned to the normal height.

If the high blood-pressure produced by adrenalin is lowered by secretin to the normal height, or below, the inhibiting action of adrenalin is not removed because the lowering of the blood-pressure is due to weakening of the heart and not to vaso-dilation.

Barium chloride may inhibit or accelerate the pancreatic flow depending upon whether it constricts the pancreatic vessels or dilates them and thus increases the blood supply to the organ.

When the pancreas is stimulated by pilocarpine its activity is inhibited not only by adrenalin but also by fresh injections of pilocarpine provided the blood supply of the organ is lessened in amount by the slowing of the heart produced by the pilocarpine.

Strophanthin Absorption from the Gastro-intestinal Tract: R. A. HATCHER.

Strophanthin is not absorbed from the alimentary canal of the rat, and the absorption is extremely irregular in the cat and the dog, and apparently so in man.

Further Studies on the Influence of Alcohol on the Composition of Urine: W. SALANT (with C. H. HINKLE).

3 to 4 c.c. of ethyl alcohol, diluted to 50 per cent., fed to dogs by mouth caused diminished excretion of total nitrogen, phosphates, chlorides, total sulphur, total and inorganic sulphates. Conjugated sulphates and neutral sulphur were, on the contrary, increased.

The Toxicity of Caffein: W. SALANT (with J. B. RIEGER).

Resistance to caffein varies in different species of animals. Rabbits and guinea-pigs can stand much larger doses than cats, dogs or pigeons. The toxic dose of caffein by mouth in the rabbit is much greater than that given subcutaneously. Toxicity of caffein is greater when injected into the muscles, still greater when given intravenously. Chronic intoxication with caffein was induced by the administration of doses insufficient to induce acute symptoms and caused emaciation and loss of strength. Starvation diminished the resistance to caffein.

Tolerance for Caffein: W. SALANT (with J. B. RIEGER).

By the subcutaneous administration of gradually increasing doses at intervals of two to five days, cats survived quantities of caffein which were 60 to 70 per cent. greater than the fatal dose. Rabbits and dogs similarly treated stood smaller doses.

On the Use of Phenolsulphonephthalein in Estimating the Function of the Kidneys: L. G. ROWNTREE and J. T. GERAGHTY.

Phenolsulphonephthalein administered subcutaneously is excreted quantitatively in the urine; in health over 90 per cent. of a 3 to 12 mg. dose being recovered in two hours as estimated by the Duboscq colorimeter. In disease of one or both kidneys, the degree to which the function is impaired can be estimated by a decrease in the amount of drug excreted. The drug is non-toxic, non-irritant, and first appears inside of ten minutes and these small doses are entirely excreted in from two to two and a half hours.

On Insufflation of the Lungs with Hydrogen, Carbon Dioxide and Air: C. C. GUTHRIE. (Read by title.)

REID HUNT,
Secretary

SOCIETIES AND ACADEMIES

THE BIOLOGICAL SOCIETY OF WASHINGTON

The 464th meeting of the society was held January 8, 1910, in the west hall of George Washington University, with President T. S. Palmer in the chair and a large attendance of members. Vernon Bailey exhibited a skull and beak of the water turkey (*Anhinga anhinga*), calling attention to the peculiar adaptation of the barblets on the sides of the beak.

The following communications were presented:

The Muskrat Industry of Maryland: D. E. Lantz.

The muskrat, because of its abundance and the adaptability of its fur to a variety of uses, has lately become the most important fur animal of North America. The tide-water region of Maryland, Delaware and New Jersey furnishes a large percentage of the entire catch of this fur, which last year amounted to five and a half million skins, bringing nearly $1,700,000 to the trappers of America. Last March the speaker visited Dorchester County on the eastern shore of Maryland and studied the methods by which trappers and marsh owners carry on the muskrat industry there.

The marshes of that region are usually leased to trappers for half the catch of fur. Measured by the returns of last year, the marshes are worth nearly as much as ordinary agricultural lands adjoining them. About 250,000 skins were taken in the county. These and the muskrat meat sold brought into Dorchester County an income of over $100,000, or more than was netted from the vast oyster industry of the county.

Muskrat meat is common on the tables of the inhabitants of that region, and the surplus is shipped to Baltimore, Wilmington and other cities, where it commands a ready sale and is eaten by all classes.

The eastern shore is noted for the large proportion of black, or melanistic, muskrats, the pelts of which command a higher price than those of the common color. Some of the Dorchester County marshes yield fully half of this variety.

The importance of wise laws for the protection of muskrats in sections where it is not destructive to dams and embankments was pointed out and the common practise of trapping this animal before its pelt is prime was condemned. The protective law for Dorchester County limits trapping to the period from January 1 to March 15, experience having shown that with this restriction the supply of this fur is reasonably constant from year to year. The animals breed three or four times during a season, producing from three to twelve young at a litter.

From Nairobi to Washington with a Collection of Living Animals: A. B. Baker.

While the Smithsonian African Expedition was at Nairobi, Mr. W. N. McMillan offered to the National Zoological Park through Lieutenant Colonel E. A. Mearns, chief of the expedition, a small collection of wild animals which he had at his ranch, "Juja Farm," about 25 miles from Nairobi. These animals, which included five lions, a leopard, two cheetahs, a warthog and several other animals and birds, had been in captivity for some time, most of them having been caught when very young. The offer was referred to Washington and an acceptance of the gift was cabled back at once.

Mr. Baker sailed from New York on July 24 and after stopping at London and Hamburg to arrange for transportation, and visiting some of the European zoological gardens, reached Mombasa, September 16 and Nairobi two days later.

In addition to the McMillan animals several antelopes, a zebra and a few other animals were secured by purchase and as gifts. Shipping boxes were made at Nairobi, much of the material used for them having been sent out with the outfit of the Smithsonian party.

Much difficulty was experienced in obtaining suitable forage, as it was not in the market at Mombasa, and a two-years' drought about Nairobi had made forage extremely scarce there. A supply was finally obtained from farther up the country, where the rains had been less scanty. The animals were shipped from Nairobi October 26, and after some delay, owing to a washout on the railway, they left Mombasa, October 28, by the steamer *Melbourne,* of the Compagnie des Messageries Maritimes.

Reaching Port Said on the night of November 8, the animals were kept on a lighter there until the twenty-first, one of the conditions imposed by the U. S. Department of Agriculture in granting the permit for entry being that the animals should not be landed at any place en route, unless it might be in England. Through the kindness of Captain S. S. Flower, director of the Giza Zoological Gardens, near Cairo, the assistance of a trained animal keeper was had during the stay at Port Said. The animals were forwarded from there by a German freight steamer, and reached Philadelphia, December 17. Favorable weather was experienced throughout the journey. A pair of gnus, and an impala died during the first four

days of the journey. They had been caught only a few days before shipping. Two young bottle-fed gazelles and a lophiomys also died, and one eland (a gift) which was very thin and weak at the start. Both of the McMillan cheetahs died before the shipment was made. The other animals arrived in excellent condition and were as follows: five lions, a leopard, Ælian's warthog, Grant's zebra, pair Livingstone's eland, pair Coke's hartebeest, female waterbuck, Thomson's gazelle, baboon (species not yet determined), lophiomys, crested eagle, Bateleur eagle, two vultures and a hawk.

The ruminants and warthog were subject to fifteen days quarantine, and Mr. A. E. Brown, director of the Philadelphia Zoological Garden, kindly received them there for that period. The others were brought to Washington at once, and reached the park December 19. All of the animals have done well thus far, except the male eland, which died suddenly at the Philadelphia garden. The autopsy did not show any condition which would account for the death. Rabbits have been inoculated with the blood of the quarantined animals, and the animals will be kept at Philadelphia until the results of this are known.

The collection includes fifteen species, of which eleven are new to the park.

The Present Status of the Bark Disease of the Chestnut: HAVEN METCALF. (Illustrated with lantern slides.)

A disastrous chestnut disease was first reported in 1904, in the vicinity of New York city, and in 1906 was stated by Murrill to be caused by a new fungus, which he named *Diaporthe parasitica*. It is probable that this disease had existed for a number of years previously about New York and on Long Island. At the present time it has spread from Saratoga County, N. Y., and Suffolk County, Mass., on the north and east, to Bedford County, Va., on the south, and Greenbriar and Preston counties, W. Va. and Westmoreland County, Pa., on the west. The fungus attacks the tree at any point above the ground, producing cankers of the bark, which spread until they meet in the bark on the opposite side, thus girdling the trunk or limb upon which they are situated, thus death may result very quickly by girdling. Sprouts are regularly formed below girdled points, and are quite characteristic of this disease. Roots and first-year wood are rarely, if ever, attacked. The most common places for the occurrence of cankers are the large crotches, the base of the trunk and the ultimate twigs. Progress of the disease is most rapid during the spring months; but south of New York, at least, inoculations may take effect at any time of the year. A debilitated tree is no more subject to attack than a healthy one. So far as known, all species and varieties of the genus *Castanea* are subject to the disease, except the Japanese chestnut which is almost completely immune. It has so far been found impossible to produce the disease in any related genera. The fungus ordinarily gains entrance through wounds, of which the commonest are the tunnels produced by various bark borers. Such wounds as these are always moist, and hence favorable to the growth of any spore. Lesions resulting from winter injury afford entrance to the fungus, but winter injury bears no other relation to the disease. The presence of the characteristic fungus forms a certain basis for distinguishing whether any given case is the bark disease or winter injury alone, but recourse must be had, even by the expert, to the damp-chamber and the compound microscope, since in dry weather the fungus may produce no spores. The bark disease shows no definite relation to the points of the compass, as the location of lesions is determined by the position of the wounds through which the fungus gained entrance. In small, smooth-barked trees, death may be prevented by a system of inspection and cutting out of diseased tissue, somewhat similar to that practised with pear-blight. On large, thick-barked trees this is impracticable, as it is impossible to distinguish disease lesions under the thick bark. It is impossible to prognosticate what the disease will or will not do in the future, as there are very few historical data from which to judge the course of this or any other plant disease. The dry summers of the past two years have slightly checked the progress of the disease, but it remains to be seen what a damp summer may do.

D. E. LANTZ,
Recording Secretary

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

AT the 440th regular meeting, January 18, 1910, Dr. C. Hart Merriam addressed the society on "Myths of California Indians." The speaker confined himself to the three great groups of central California. Their myths, though they are obviously not homogenous, have the same personages and characters, viz., the pre-Indian inhabitants

who disappeared at the advent of the Indians and the coyote man. The myths quoted referred to the acquisition of fire.

In the discussion Drs. Fewkes, Swanton and Hewitt quoted parallels from the Casa Grande, the Northern Pacific and the Iroquois, respectively.

Dr. Walter Hough followed with a paper on "Incense and Incense Burners." The use of incense in America for religious ceremonies has never been very thoroughly studied. The paper treated in a general way of the diffusion of the materials employed and especially of the apparatus in which incense is burned. The discussion was therefore confined largely to the apparatus found among the cultured tribes of Central America, Mexico and the southwest United States. In the latter area occur forms which are possibly connected with those in Mexico. The paper also discussed the pipe as an incensario.

In the discussion Dr. Casanowicz dwelt on the use of incense, in domestic and social life as well as in the cult and magic, among the ancient nations and quoted passages which hint at a dæmonifuge background of its use. Mr. Hewitt pointed out that among the Iroquois incense is sometimes employed to emphasize a petition. Dr. Fewkes referred to the fact that among the Hopi Indians all ceremonies opened and closed with a smoke. Its object is to obtain rain; the smoke is to make a cloud, and the rain-god seeing the cloud would send rain.

I. M. Casanowicz,
Secretary

National Museum

THE AMERICAN CHEMICAL SOCIETY
NORTHEASTERN SECTION

The ninety-sixth regular meeting of the section was held on January 21, 1910, at the Twentieth Century Club, Boston.

A motion was passed in favor of holding alternated bi-monthly meetings jointly with the New England Section of the Society of Chemical Industry.

Professor Louis Derr, of the Massachusetts Institute of Technology, presented a paper entitled "Color Photography at the Present Time." After a brief statement of the underlying principles of color photography, the speaker pointed out the advantages of the process depending upon the use of finely ruled screens, and showed why it had failed commercially. He then described the French single plate process involving the use of dyed starch grains, and he showed how some of the very recent English single plates were prepared and used. The lecture was profusely illustrated with very beautiful and striking examples of color photography, including some most remarkable results with brilliant micro-photographs.

There were about one hundred members and guests present.

K. L. Mark,
Secretary

RHODE ISLAND SECTION

The regular meeting of the section was held January 20, 1910, at the University Club, preceded by the usual informal dinner.

The paper for the evening was given by Dr. John E. Bucher, of Brown University, on the subject "The Structure of Retene and its Relation to some Natural Resins." The presentation of Dr. Bucher's work, which was illustrated by charts, showed conclusively that the correct structure of retene is 8-methyl-2-isopropylphenanthrene and not the formula ordinarily published in the literature.

Several new and valuable methods of oxidation were developed during the work, notably the use of pyridine as a solvent for the potassium permanganate oxidation of substances insoluble in water; and also, oxidation by nitric acid in the presence of manganese nitrate as a catalytic agent.

As a continuation of the work the relation of retene to common rosin and abietic acid is now being studied.

The paper will soon be published in the *Journal of the American Chemical Society.*

Albert W. Claflin,
Secretary

Providence, R. I.

CLEVELAND SECTION

The third regular meeting of the session of 1909–10 was held in the Main Building of Case School of Applied Science, December 13.

The following papers were presented: Charles F. Brush, "The Commercial Manufacture of Oxygen from the Atmosphere"; F. R. Van Horn, "The Brick Industry of Cleveland."

This meeting marked the end of the first year of the existence of the Cleveland Section and was certainly the most interesting and successful meeting since the section was organized.

N. A. Dubois,
Secretary